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March 31, 1980

2101-1563-043

Alberta Environment
Municipal Engineering Branch
Pollution Control Division
9820 - 106 Street
Edmonton, Alberta
T5K 2J6

Attention: Mr. D. McIntyre, P.Eng.

Dear Sir:

Re: Drumheller-Three Hills-Trochu
Regional Water Supply Study

We are pleased to submit our report on the Drumheller-Three Hills-Trochu Regional Water Supply Study. This report was prepared by W. Pfiffner and D. Kamanga with assistance from D. E. Mortin, D. Eves, R. L. Nowak, E. Wolski and the undersigned.

We would be pleased to meet with you at your convenience to discuss the report in further detail.

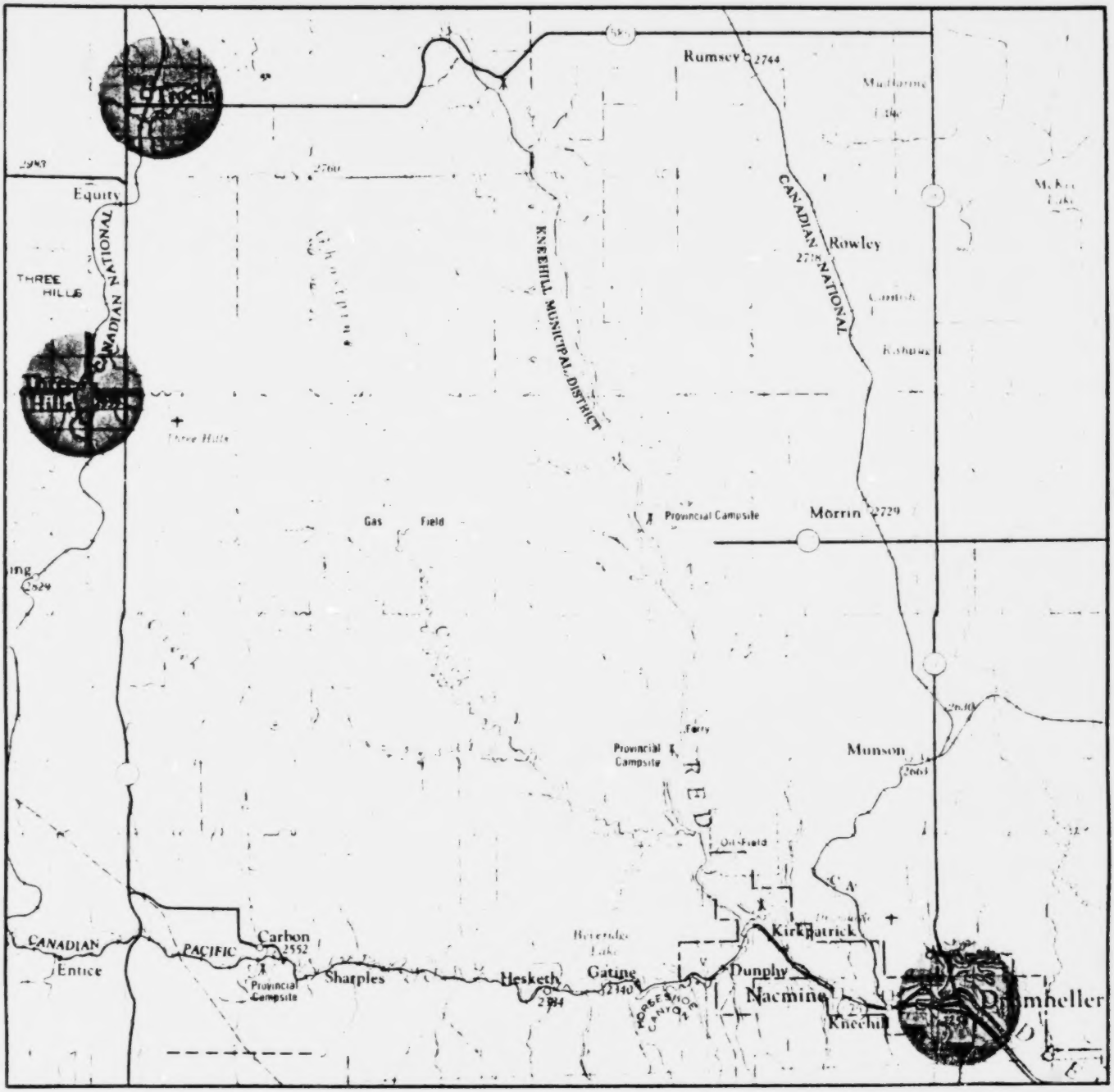
Yours very truly,

UNDERWOOD McLELLAN LTD.

M. W. Slezak.

M. W. Slezak, P. Eng.
Department Head
Environmental Engineering

DRUMHELLER • THREE HILLS • TROCHU
REGIONAL WATER SUPPLY STUDY



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prepared for: ALBERTA ENVIRONMENT

prepared by: UNDERWOOD McLELLAN LTD.

MARCH 1980

DRUMHELLER, THREE HILLS & TROCHU
REGIONAL WATER SUPPLY STUDY

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SUMMARY AND RECOMMENDATIONS

SUMMARY

Study Terms of Reference

Alberta Environment's letters of November 27, 1979, and December 17, 1979, directed Underwood McLellan Ltd. to assess alternative systems for providing water to the communities of Drumheller, Three Hills and Trochu.

The following four alternatives were considered:

Alternative 1A - Drumheller would be provided with an independent water supply system with the intake storage and treatment facility located at Drumheller. A "Mini" regional system with the Red Deer River as the source would supply treated water to the Towns of Three Hills and Trochu. In the "Mini" regional system, the treatment plant and offstream storage are located on a site east of Trochu on the west side of the Red Deer River near Highway 585.

Alternative 1B - this alternative is similar to Alternative 1A with the exception of the raw water source and the location of water treatment facilities for the "Mini" regional system. Three Hills Creek is the raw water source and water treatment facilities are located in Three Hills.

Alternative 1C - the water supply system proposed in this Alternative for Three Hills and Trochu is similar to Alternative 1A with the exception that the offstream storage would be located in Trochu. Drumheller's system would be identical to that described in Alternative 1A.

Alternative 2 - this alternative examines a regional water supply system which is common to the communities of Drumheller, Three Hills and Trochu. The water source for the regional system would be the Red

Deer River. The water treatment plant would be located on the west side of the Red Deer River, north of Munson's Ferry.

In addition, the following specific terms of reference were addressed:

- preparation of population projections for each of the municipalities to be served including Drumheller, Three Hills, Trochu and the Municipal District of Kneehill;

- preparation of water consumption projections for each of the municipalities;

- review of the capability of existing municipal facilities;

- location of a potential site for a regional water treatment plant on the Red Deer River to serve the above mentioned municipalities;

- determination of pipe sizes and route location of water lines serving the above mentioned municipalities;

- evaluation of the alternative of providing a regional water facility compared with cost of developing independent facilities for each of the municipalities utilizing studies or reports prepared for the municipalities;

- preparation of an economic analysis which includes capital and operating costs;

- submission of a report outlining findings and recommendations.

In order to address the terms of reference fully, it was necessary to evaluate the condition of the existing individual water supply systems for each of the three communities with regards to their capability of meeting present and future water requirements.

Future Considerations

1. Population

Future projections are based on a 20 year design period (1980-2000).

Drumheller Basin:

The population projections for the City of Drumheller were developed with reference to the Calgary Regional Planning Commission's report of 1977, Alberta 1979 Municipal Affairs Official Population List, discussions with Drumheller's City Engineer and subsequent discussions with the Palliser Regional Planning Commission. The analysis includes the future population for adjacent communities such as Nacmine. From the analysis, it is shown that the population of the Drumheller basin will be 12,228 persons in the year 2000.

Town of Three Hills:

The Town of Three Hills has experienced significant growth for the last six years. For instance, in 1974 the population was recorded as 1435 and subsequently increased to 1758 in 1978. This is an annual growth rate of approximately 6 percent per year. The analysis shows that the combined population of Three Hills, Grantville and Ruarkville when projected at a rate of 3.5 percent per year will be approximately 5575 persons in the year 2000.

The population for the Prairie Bible Institute was assumed to increase rather slowly at an annual rate of 1 percent. It is anticipated that the population for the Prairie Bible Institute will be 1778 persons in the year 2000.

Town of Trochu:

Historical census figures show that the population for the Town of Trochu increased from 752 in 1976 to 852 in 1979. This is equivalent to an increase of approximately 4.4 percent per year. In view of anticipated water demand requirements induced by improved water supply services and economic growth, the Calgary Regional Planning Commission suggest an annual growth of 5 percent. On this basis the analysis shows that the population for the Town of Trochu will be 2374 persons in the year 2000.

2. Water Consumption

The analysis of water consumption for the communities of Drumheller, Three Hills and Trochu, shows that apart from population growth, water consumption increases are normally associated with improved water supply services, economic growth, types of industries and inherent climatic conditions peculiar to each community because of its geographical location.

City of Drumheller:

For the City of Drumheller, pumping records showed that the overall water consumption increased from 72 gallons per capita per day in 1969 to 100 gallons per capita per day in 1979. This represents an increase of approximately 3 gallons per capita per day per year. It must be noted that the Penitentiary, which is the largest single water user, has averaged over 180 gallons per capita per day during summer months. In view of the past historical water consumption data compounded by the hot climatic conditions during summer months in the Drumheller basin, it is anticipated that water consumption would continue to increase at the rate of 3 gallons per capita per day. As a result, the maximum day water demand requirements for the entire community is expected to increase to 3660 gallons per minute in the year 2000 from the present 1146 gallons per minute.

Town of Three Hills:

The basic water consumption figure for the Town of Three Hills was determined from recently repaired meters. A review of the limited available 1979 meter recordings, show that the per capita consumption for the Prairie Bible Institute has been averaging 54 gallons per day; Three Hills, Grantville and Ruarkville have been averaging 50 gallons per day. It must be noted that Three Hills has embarked on a program of water rationing. It is anticipated that, without a policy of water rationing, the 1980 water consumption would approximate 71 gallons per capita per day, for Three Hills, Grantville and Ruarkville. An annual increase of 1 gallons per capita per day per year has been assumed to project future water demand requirements. This increase rate is typical for similar small Towns such as Three Hills in the south central area.

The analysis shows that the Town of Three Hills, Grantville, Ruarkville and the Prairie Bible Institute will require approximately 850 gallons per minute in the year 2000 as compared to the present maximum demand of 326 gallons per minute.

Town of Trochu:

The Town of Trochu have estimated that water consumption for the Town is approximately 79 gallons per capita per day at present. Since the Town of Trochu has the same characteristics as the Town of Three Hills, an increase of 1 gallons per capita per day was assumed. The anticipated maximum day water requirement is approximately 335 gallons per minute in year 2000, as compared to 97 gallons per minute in 1979.

Description and Assessment of Drumheller, Three Hills and Trochu Existing Water Supply Facilities

City of Drumheller Water Supply System:

The City of Drumheller presently obtains raw water from two sources, namely the Red Deer River, and groundwater from two wells. River water intake pumps are limited to deliver 1300 gallons per minute, and well production has declined over the years from 1720 gallons per minute to 350 gallons per minute. The operation of the water supply system in the past, has been to blend river water with groundwater. The mixed water (turbid river water and groundwater) was processed through a 1100 gallons per minute solids contact unit and the two filters which have a total design capacity of 1300 gallons per minute. The overall water treatment process apart from blending, consists of cold lime softening in a solids contact unit, filtration and disinfection with chlorine. The mode of operation by which river water was mixed with groundwater is no longer practical as the filters have now deteriorated as a result of filtering turbid river water over several years. In addition, water consumption has now increased, and since well water yield has declined the existing facilities cannot cope with increased water demands. Limitations of the existing facilitites and historical increase in water consumption all point to the need for a commitment to develop a system which would permit the year round use of the Red Deer River as the ultimate reliable source for the City. In view of high suspended solids concentration the concept of offstream storage appears to be the only economical solution which would render raw water suitable at all times and would meet the required maximum demand of 3660 gallons per minute in the year 2000.

Towns of Three Hills, Ruarkville, Grantville and Trochu:

The seven wells which provide water for the Towns of Three Hills, Ruarkville, Grantville and Prairie Bible Institute have a combined output capacity of 314 gallons per minute, whereas the year 2000 water

demand is 850 gallons per minute. In addition, analysis of water quality shows that the water is of poor quality when compared to the acceptable limits in the Canadian Drinking Water Standards. The Town has already initiated the program of water rationing in order to meet the increasing water demand requirements. Therefore, the long term water supply sources considered for these communities were: Three Hill's Creek and the Red Deer River. The Town of Trochu's water supply system which is from wells, has recently been upgraded to meet present and to the year 1985 water demand requirements. However, a water quality analysis undertaken by the Alberta Environment documented in a report entitled, "Trochu Hydrogeological Study - 1976" stated that groundwater was of poor quality.

Proposed Alternatives:

Limitations imposed by the existing individual water supply systems to meet projected water demands dictate the need to develop an economical reliable system that will meet present and the year 2000 water demand requirements.

Various alternatives to supply water to the City of Drumheller, Town of Three Hills and Trochu and adjacent communities were examined and these are as follows:

Alternative 1A - considers an independent water supply system for Drumheller and a "Mini" regional water supply system for the Towns of Three Hills and Trochu. The water treatment and offstream storage facilities for the "Mini" regional water supply system would be located on a site east of Trochu, west of the Red Deer River near Highway 585.

Alternative 1B - considers a system similar to Alternative 1A with the exception of the source of supply which would be Three Hills Creek for the "Mini" regional supply to Three Hills, Trochu and adjacent communities.

Alternative 1C - considers a system also similar to Alternative 1A with the exception of the location of offstream storage pond and water treatment plant facilities for the "Mini" regional system. These facilities would be located at Trochu instead of being at the Red Deer River.

Alternative 2 - considers a regional water supply system with raw water storage and treatment facilities located on the west bank of the Red Deer River immediately north of Munson's Ferry. This system would supply treated water to all communities from a central location.

A summary of capital costs for these alternatives is as follows:

Alternative 1A	Drumheller Water Supply System	"Mini" Regional Water Supply System from Red Deer River Off-stream Storage and Treatment at River	Total Capital Cost to all Communities for the Alternative
	$8,435,000	$7,206,000	$15,641,000
Alternative 1B	Drumheller System	"Mini" Regional System Three Hills Creek Source	
	$8,435,000	$7,331,500	$15,766,500
Alternative 1C	Drumheller System	"Mini" Regional Offstream Storage at Trochu	
	$8,435,000	$8,008,000	$16,443,000
Alternative 2	Regional Water Supply System		$15,625,000

Alternative 3	Drumheller Independent Water Supply System	$8,435,000
	Three Hills Independent Water Supply System; Water Source Red Deer River	$6,591,000
	Trochu Independent Water Supply System Groundwater (wells)	Complete information unavailable at the time of publication

Operating costs for these alternatives as summarized in the following tabulation shows that the regional system (Alternative No. 2) has the lowest total annual operating costs.

Item	Operating Costs 1980	1985	1990	1995	2000
Alternative 1A					
- Drumheller System	$137,375	$149,925	$166,425	$183,115	$203,655
- "Mini" Regional System	118,500	128,850	142,630	159,150	180,980
TOTAL	$255,895	$278,775	$309,055	$342,265	$384,635
Alternative 1B					
- Drumheller System	137,375	149,925	166,425	183,115	203,655
- "Mini" Regional System	105,390	110,820	118,960	127,580	138,710
TOTAL	$242,765	$260,745	$285,385	$310,695	$342,365
Alternative 1C					
- Drumheller System	137,375	149,925	166,425	183,115	203,655
- "Mini" Regional System	115,150	122,740	134,340	146,380	161,890
TOTAL	$252,525	$272,665	$300,765	$329,495	$365,545
Alternative 2					
- Regional System to Serve All Communities	$199,540	$222,440	$250,430	$282,390	$325,710

Note: All costs are based on 1980 dollars.

A comparative cost analysis (present worth) of immediate and deferred capital, operation and maintenance costs over the 20 year design period indicates that a Regional Water Supply System (Alternative 2) serving Drumheller, Three Hills, Trochu and adjacent communities was the most economical. The total present worth for the alternatives considered are summarized as follows:

Item	Total Present Worth Based on Medium Net Effective Interest Rate
Alternative 1A	$20,740,000
Alternative 1B	$20,312,000
Alternative 1C	$21,292,000
Alternative 2	$19,729,000
Alternative 3 - Drumheller Independent System	$11,112,000
- Three Hills Independent System	$8,842,000
- Trochu	information not available at publication

Alternatives 1A, 1B, and 1C as described previously all involve a separate water supply system for Drumheller and a "Mini" regional system serving Three Hills, Trochu and adjacent communities. Variations in the source (Alternative 1B - Three Hills Creek) and in the location of offstream storage and treatment facilities (Alternatives 1A and 1C) have been examined for the "Mini" Regional System.

The site selected for the regional system (Alternative No. 2) provides considerable flexibility for expansion of offstream storage (raw water) treatment and pumping facilities beyond the selected 20 year design period. In addition, the channel characteristics for the Red Deer River are considered to be good for the location of an intake since the channel is narrow and relatively deep at this site. Another advantage of implementing a regional system is the need for one group of operating staff as opposed to staffing facilities for the individual communities. In this regard, senior staff presently operating the Drumheller water treatment plant could be utilized to form the nucleus of staff required for the regional water supply facilities. The disadvantage of implementing a regional water supply system is that individual communities lose some degree of freedom in the day to day operation of the facilities. This assumes that the regional facilities would be operated by some form of regional authority.

RECOMMENDATIONS

To ensure that the present and future water demand requirements are met to satisfy projected growth in Drumheller, Three Hills, Trochu and surrounding communities,it is recommended that:

1. A regional water supply and treatment facility be constructed on the basis of a least present worth cost evaluated over a 20-year design period.

2. The site for the regional offstream raw water storage and treatment facilities be located west of the Red Deer River on a site immediately north of Munson Ferry.

3. Upon approval of the recommendation contained in items 1 and 2, above, by the communities concerned, undertake a detailed soils investigation to establish the suitability of soils for construction of the offstream raw water storage reservoir.

4. Concurrent with item 3, above, land be purchased for the storage, pumping and treatment facilities and easements be acquired for the transmission mains.

5. The recommended procedures for project implementation as outlined in Section 6 of this report be implemented.

Respectfully Submitted:

UNDERWOOD McLELLAN LTD.

W. K. Pfiffner

D. Kamanga, P. Eng.

1.0 INTRODUCTION

Alberta Environment, by letters of November 27, 1979, and December 17, 1979, authorized Underwood McLellan Ltd. to undertake a regional water supply study for the communities of Drumheller, Three Hills and Trochu.

A number of alternative water supply systems were assessed in terms of cost and long term reliability and are identified as follows:

Alternative 1A - Drumheller would have an independent water supply system whereas the communities of Three Hills and Trochu would be supplied by a "Mini" regional water supply system with the Red Deer River as the source of supply. Offstream storage and treatment plant facilities would be located near the river.

Alternative 1B - this system is similar to Alternative 1A with the exception of the source of supply which would be Three Hills Creek for the "Mini" regional supply to Three Hills and Trochu.

Alternative 1C - this system is similar to Alternative 1A with the exception of the location of offstream storage and treatment plant facilities for the "Mini" regional system. These facilities would be located at Trochu instead of being at the Red Deer River.

Alternative 2 - this alternative provides for a regional water supply system to Drumheller, Three Hills and Trochu. Raw Water source would be the Red Deer River and offstream storage and treatment facilities would be located on the west bank of the river - north of Munson's Ferry.

Alternative 3 - this alternative provides independent water supply systems for each of the communities of Drumheller, Three Hills and Trochu.

In addition, the report addresses the following terms of reference:

- preparation of population projections for each of the municipalities to be served including Drumheller, Three Hills, Trochu and the Municipal District of Kneehill;

- preparation of water consumption projections for each of the municipalities;

- review of the capability of existing municipal facilities;

- location of a potential site for a regional water treatment plant on the Red Deer River to serve the above mentioned municipalities;

- determination of pipe sizes and route location of water lines serving the above mentioned municipalities;

- evaluation of the alternative of providing a regional water facility compared with cost of developing independent facilities for each of the municipalities utilizing studies or reports prepared for the municipalities;

- preparation of an economic analysis which includes capital and operating costs;

- submission of a report outlining findings and recommendations.

2.0 DESCRIPTION AND ASSESSMENT OF EXISTING WATER SUPPLY AND TREATMENT FACILITIES

2.1 City of Drumheller

The present two main sources of water supply for the City of Drumheller are Red Deer River and groundwater from Well No. 3 and No. 4. The river intake capacity is approximately 1,300 Imperial gallons per minute and Well No. 3 supplies approximately 350 Imperial gallons per minute while Well No. 4 has recently deteriorated to a negligible production yield. The total combined raw water supply capacity is approximately 1,650 Imperial gallons per minute.

The overall water treatment process basically involves disinfection by chlorine, filtration and cold lime softening in a solids contact unit. The capacity of the clarifier in use at the present time is 1,100 gallons per minute and performs poorly due to overloading during periods of high river turbidity. The four existing filters, with a total filter area of approximately 650 square feet, have a design capacity of 2.5 gallons per minute per square foot (1,625 gallons per minute). However, due to pretreatment problems associated with high river turbidity and floc carry-over to the filters, the filter rate has recently deteriorated significantly.

Three high lift pumps located at the water treatment plant have a combined capacity of approximately 1,350 gallons per minute and supply water through the distribution system into three clear water storage reservoirs.

Operation

In the past, the City of Drumheller plant operators have blended Red Deer River water with groundwater from Wells No. 3 and No. 4. This mixture of groundwater and river water was processed through the treatment plant's units which in turn rendered it safe for human and commercial use. The mode of operation in which groundwater was blended with river water afforded the plant operator the luxury of diluting the high concentrations of suspended load during periods of high river sediment, although this was done at the expense of gradual filter blinding. This style of operation appeared to work well simply because the water demand rate at the time was smaller than what is presently being experienced. Recently, as a result of gradual deterioration of filter beds caused by turbidity and encrustation from alkalinity deposits, it has become increasingly difficult to keep up with high water demand rates. In fact, at present, in an attempt to barely meet average water demand rates, the plant operators have pumped the 350 gallons per minute from Wells No. 3 and No. 4 directly into the clearwell during periods of high river suspended load concentration.

Assessment of Existing Facilities

The analysis of the present facilities with regards to their capacity to meet present and future water demand rates and provide the necessary fire protection for the community indicated that the present facilities are inadequate. Detailed tests showed that the future average daily demands would not be satisfied by the existing facilities. Simulated 5-hour fire flows plus domestic consumption at maximum daily rates could not be met by the present treatment plant and treated water storage reservoirs even at 100% depletion.

In view of the limitations of the existing facilities to meet future demand, an action plan was identified which included implementation of the following:

- Interim measures
- Immediate measures
- Long term measures

A full discussion of these measures is outlined in section 4.

2.2 Town of Three Hills

2.2.1 Description and Operation of Existing Facilities

Existing Facilities

The present water supply for the Town of Three Hills consists of seven wells which are located at two to three miles southwest of the Town.

The combined maximum output from these wells is 314 gallons per minute. There is a 150,000 gallon underground storage reservoir located at Railway Avenue South, and a 40,000 gallon elevated storage tower located downtown. There are no treatment facilities. Two high lift pumps are located adjacent to the 150,000 gallon underground storage.

Operation

Groundwater is pumped from the seven wells through a 6-inch diameter main into the 150,000 gallon underground storage reservoir. In 1978 a booster station was installed to improve the capacity of the existing 6-inch diameter supply main. From the underground storage, water

is pumped through the distribution system into the 40,000 gallon elevated tower.

A review of the Alberta Research Council groundwater central data file indicated that groundwater quality in the Three Hills area is relatively poor, contains high total dissolved solids (inorganic salts and minerals), characterized by high concentrations of salts such as sulphate, nitrate bicarbonate and chloride.

Assessment of Existing Facilities

A graphical presentation of projected water demand requirements indicate a critical point in 1981 where the required water consumption rates for 1981 are above the production capacity of the existing wells. In addition, the graphical analysis shows that the treated water storage capacity of 190,000 gallons is insufficient to supply present peak hour demands and the required fire flows.

2.3 Town of Trochu

2.3.1 Description and Operation of Existing Facilities

Existing Facilities

The Town of Trochu is supplied by five wells with an approximate combined output rate of 113 gallons per minute as stated by Engineering Canada Associates. There are two underground reservoirs with a total storage capacity of 550,000 gallons. Adjacent to the 500,000 gallon reservoir, there are high lift pumps with a total capacity of approximately 1800 gallons per minute.

Operation

Groundwater is pumped from four wells and stored in the two reservoirs. From the 500,000 gallon reservoir, water is distributed through the pipe system for domestic and commercial use.

Assessment of Existing Facilities

It is estimated that the existing wells are capable of producing 52 to 113 gallons per minute. Indications are that the maximum well production output of 113 gallons per minute may meet projected maximum day demands until the year 1985. In 1979, a 500,000 gallon reservoir was constructed which now provides fire protection for the community including water consumption.

A water quality assessment undertaken by Alberta Environment documented in a report entitled "Trochu Hydrogeological Study 1976" stated that the groundwater was of poor quality. The concentrations of sodium chloride and alkaline salts were determined to be above the limits stipulated by the Canadian Drinking Water Standards.

3.0 FUTURE POPULATION AND WATER DEMAND PROJECTIONS

3.1 City of Drumheller

3.1.1 Future Considerations

In order to evaluate the capability of the existing facilities in satisfying future water demand requirements based on the 20-year design period, it was necessary to determine the population growth pattern including industrial development trends in the community.

3.1.2 Population

Basic assumptions and a population historical growth pattern were derived with reference to the Calgary Regional Planning Commission's report of 1977, Volume 1, the Alberta Municipal Affairs Official Population List and discussions with Drumheller's city engineer. Subsequent discussions with the Palliser Regional Planning Commission indicated that there was an agreement with the assumptions used in projecting future population growth for the Drumheller basin.

The Calgary Regional Planning Commission assumed an annual 5% population growth percentage, at which rate a population of 18,000 persons would be reached by the year 2000 or within the 20-year design period. It was felt that this growth rate was rather too optimistic since available census records showed a population of 5,200 persons in 1968 and 6,563 persons in 1978 for the Drumheller basin. This represents a population growth rate of 2.6% per year for the ten year period. On this basis it was considered reasonable to select a 3% population growth rate for the

City of Drumheller. In addition, this allows for induced consumption and population growth effects caused by either improvements to the water supply services or sudden economic development due to a new major industry.

Table 3.1 summarizes the 3% annual population growth rate discussed.

Table 3.1
Past, Present and Future Population

Year	City of Drumheller Including Nacmine @ 3% Growth Rate
1977	6,487(1)
1978	6,563(1)
1979	6,573(1)
1980	6,770
1985	7,848
1990	9,099
1995	10,548
2000	12,228
2005	14,176
2010	16,434
2015	19,051
2020	22,085

NOTE: (1) The source of this information is the Alberta Municipal Affairs Official Population List 1979 and subsequent telephone conversations with Alberta Municipal Affairs Officials.

3.1.3 Water Consumption

Future water demand projections were based on existing pumping records. A detailed analysis of past records revealed that water consumption varied from 72 gallons per capita per day to 100 gallons per capita per day for the years 1969 and 1979, respectively, as shown in Table 3.2.

Table 3.2
Unit Water Consumption Rates

	1969	1976	1977	1978	1979
Per Capita Average Daily Demand (gcd)	72	86	88	96	100

NOTES: - All gallons are in Imperial units
- gcd refers to gallons per capita per day

Therefore, the average annual per capita increase for the last ten years (1969 to 1979) is 2.8 gallons per capita per day per year. It would appear reasonable, therefore, to increase per capita consumption by three gallons per day per year in projecting annual water demand rates. This rate allows a margin of safety in the sizing of water supply facilities. An allowance of 0.29 million gallons per day was included in the projected water demand figures for industrial development.

3.1.4 Peaking Factors

From pumping rates, hourly, daily and monthly water consumption variations were determined. Peaking factors of 2.5 and 3.1 for maximum daily and peak hourly rates, respectively, were established as shown in Table 3.3.

Table 3.3
Maximum Daily and Monthly Water Demand Rates

	1976		1977		1978		1979	
	Month	mg	Month	mg	Month	mg	Month	mg
Max. Monthly Demand	July	27.56	June	29.02	July	34.32	July	29.60
Max. Daily Demand	July 26	1.20	July 22	1.40	July 25	1.50	July 8	1.75
Peak Hourly Demand	July 26	1.87	June	1.87	July	1.87	July	1.87
Peaking Factors								
Max. Monthly Demand/Average Daily Demand	1.7		1.7		1.8		1.4	
Max. Daily/Avg Daily Demand(1)	2.2		2.5		2.4		2.7	
Peak Hourly Demand/Avg. Daily Demand(2)	3.4		3.3		3.0		2.7	

Notes: (1) The average maximum day factor is 2.5 for the last three years.

(2) The average peak hourly factor is 3.1 for the last three years.

In order to obtain maximum daily demand rate, the average daily demand is multiplied by 2.5 and the peak hourly rate is obtained by multiplying the average daily rate by 3.

The projected water demand requirements are summarized in Table 3.4.

Table 3.4
Projected Water Demand Rates

			Average Daily Demand													
			Domestic Usage		Industrial[1] Usage		Total		Fire[2] Demand		Peak Hourly[3] Demand		Maximum[4] Daily Demand		Maximum Daily Plus Fire Flow	
Year	Pop.	gcd	mgd	gpm	mgd	gpm	mgd	gpm	mgd	gpm	mgd	gpm	mgd	gpm	mgd	gpm
1979	6,573	100	0.66	458			0.66	458	1.35	4500	1.98	1,375	1.65	1146	3.00	2,083
1980	6,770	103	0.70	486			0.70	486	1.35	4500	2.10	1,458	1.75	1215	3.10	2,153
1983	7,398	112	0.83	575	0.29	200	1.12	778	1.35	4500	2.78	1,930	2.37	1646	3.72	2,583
1985	7,848	118	0.93	646	0.29	200	1.22	847	1.35	4500	3.08	2,139	2.62	1819	3.97	2,757
1990	9,099	133	1.21	840	0.29	200	1.50	1042	1.35	4500	3.92	2,722	3.32	2306	4.67	3,243
1995	10,548	148	1.56	1083	0.29	200	1.85	1285	1.35	4500	4.97	3,451	4.19	2910	5.54	3,847
2000	12,228	163	1.99	1382	0.29	200	2.28	1583	1.35	4500	6.26	4,347	5.27	3660	6.62	4,597
2020	22,085	223	4.92	3417	0.29	200	5.21	3618	1.35	4500	15.05	10,451	12.59	8743	13.94	9,681

NOTE: (1) A rate of 200 gallons per minute has been allowed for industrial usage.

(2) The Insurance Advisory Organization recommends a fire flow of 1500 gallons per minute for a five hour duration for the City of Drumheller.

(3) The peak hourly factor is calculated to be 3.0 from pumping records.

(4) The maximum daily demand factor is calculated to be 2.5 from water usage records.

- gcd refers to gallons per capita per day
- mgd refers to million gallons per day
- gpm refers to gallons per minute

3.1.5 Treated Water Storage Requirements

The present system has three storage reservoirs with a total capacity of 975,000 gallons.

A water supply system, to be fully adequate, must deliver the necessary fire flow at any point in the distribution system for the required duration of fire flow with consumption at maximum demand rate. In addition, it is normal practice to design a treated water storage reservoir to satisfy peak hourly demand rates and provide adequate storage for emergencies.

These three major conditions were considered and the required storage capacities are outlined in Table 3.5. The City of Drumheller will need approximately 1,800,000 gallons and 2,700,000 gallons of treated water storage in 1980 and the year 2000, respectively.

3.2 Town of Three Hills

3.2.1 Future Considerations

For the Town of Three Hills, the assessment of existing facilities to satisfy the increasing water demand was based on population growth pattern discussed in the report entitled "Town of Three Hills Water Supply Study" which was submitted to Council in October 1979 by Underwood McLellan Ltd.

3.2.2 Population

The combined population growth rate for the towns, Three Hills, Grantville and Ruarkville, is projected at approximately 3.5% per year. The Town of Three Hills has experienced phenomenal growth for the last four years.

Table 3.5
Treated Water Storage Requirements

Year	Pop.	Fire[2] Flow Reserve mg	Equalizing[3] Operating Storage mg	Emergency[4] Reserve mg	Total Storage Required: With Emergency mg	Total Storage Required: Without Emergency mg	Deficit/Surplus[1]: Emergency Reserve Excluded mg	Deficit/Surplus[1]: Emergency Reserve Included mg
1979	6,573	1.35	0.41	0.66	2.42	1.76	-0.78	-1.44
1980	6,770	1.35	0.47	0.70	2.52	1.82	-0.84	-1.54
2000	12,228	1.35	1.32	2.28	4.95	2.67	-1.69	-3.97

NOTES:

(1) The deficit (-) or surplus (+) is determined by comparing the required projected storage capacity with the existing treated water storage capacity which is approximately 0.98 million gallons (4545 m^3). Deficit simply indicates the amount by which the existing treated water storage must be increased to meet both the projected demand and the Canadian Public Fire Protection Survey requirements.

(2) Fire flows were calculated on the rate of 4500 igpm for a 5-hour fire duration.

(3) An allowance in the amount of 25% of maximum daily demand has been provided to allow for hourly demand fluctuation in excess of the peak day demand.

(4) Emergency storage is normally provided in water engineering practice to take care of uncontrollable breakdowns in water supply and treatment facilities.

- mg refers to million gallons

For instance, in 1974 the population was recorded to be 1,435, and in 1978 it increased to 1,758. This is an annual percentage growth rate of approximately 6% per year. Therefore, it was assumed reasonable to project the combined future growth for the Towns of Three Hills, Grantville and Ruarkville at 3.5% per year. Table 3.6 summarizes the projected population figures.

Table 3.6
Future Population

Year	Three Hills Grantville Ruarkville	Prairie Bible Institute
1979	2,101	1,442
1980	2,200	1,456
1985	2,766	1,531
1990	3,488	1,609
1995	4,408	1,691
2000	5,552	1,778
2020	8,915	2,100

3.2.3 Water Consumption

Future water demand projections for the Town of Three Hills were determined from recently repaired meters. Examination of 1979 meter readings showed that the per capita consumption for the Prairie Bible Institute has been averaging at 54 gallons per day and for Three Hills, Grantville and Ruarkville at 50 gallons per day. It must be noted that Three Hills is on a water rationing program, hence the low consumption compared to Trochu. For the purposes of this report, the basic consumption for 1980 is estimated at 71 gallons per capita per day for Three Hills, Grantville and Ruarkville, and 55 gallons per capita per day for the Prairie Bible Institute. Due to

insufficient past water usage records to develop water consumption increases, a growth rate of 1 gallon per capita per year was assumed. This rate of increase in water consumption is typical for similar small towns such as Three Hills in Alberta.

3.2.4 Peaking Factors

On the basis of limited available information, a peaking factor of 2 was assumed to determine maximum demand rates. This peaking factor is typical for similar towns, like Three Hills, in Alberta.

The projected water demand requirements are summarized in Table 3.7.

Table 3.7
Future Population and Projected
Water Demand, Town of Three Hills

Year	Population Three Hills Grantville Ruarkville	Pop. P.B.I.	Three Hills Grantville Ruarkville gcd	P.B.I. gcd	Total Avg. Day Demand mgd	Total Max. Day Demand mgd
1979	2,101	1,442	58*	54*	0.20	0.40
1980	2,200	1,456	71	55	0.24	0.47
1985	2,766	1,531	76	60	0.30	0.60
1990	3,488	1,609	81	65	0.39	0.78
1995	4,408	1,691	86	70	0.50	0.99
2000	5,552	1,778	91	75	0.64	1.28
2020	8,915	2,100	101	85	1.08	2.16

P.B.I. = Prairie Bible Institute
gcd = gallons per capita per day
mgd = million gallons per day
*1979 water demands shown are actual metered demands

3.2.5 Treated Water Storage

In order to provide fire protection emergency supply and satisfy peak hourly demand requirements, the necessary treated water storage capacity for the Town of Three Hills was estimated to be 800,000 gallons. Presently, the total storage is 150,000 gallons. Table 3.8 summarizes the required storage capacities in 1980 and the year 2000.

Table 3.8
Treated Water Storage Requirements

Year	Fire[1] Flow Reserve mg	Operation[2] Storage mg	Emergency[3] Reserve mg	Total Storage Required With Emergency mg	Total Storage Required Without Emergency mg
1980	0.45	0.12	0.24	0.81	0.57
2000	0.45	0.32	0.64	1.41	0.77

Notes:

(1) Fire flows were calculated at the rate of 2,500 gallons per minute for a 3-hour fire duration.

(2) An allowance in the amount of 25% of maximum daily demand has been provided to allow for hourly demand fluctuation in excess of the peak day demand.

(3) Emergency storage is normally provided in water engineering practice to take care of uncontrollable breakdowns of major components in water supply and treatment facilities. However, for small rural towns, this component is considered a luxury, and therefore it is not considered critical in this case.

3.3 Town of Trochu

3.3.1 Future Considerations

Future considerations regarding the capacity of the existing facilities to meet water demand increases were

related to population growth pattern including induced water requirements as a result of improved water supply facilities or economic growth.

3.3.2 Population

Population projections were developed on information obtained from the Calgary Regional Planning Commission and Engineering Canada Associates. Historical census figures show that the population for the Town of Trochu increased from 752 in 1976 to 852 in 1979. This is equivalent to an increase of approximately 4.4% per year. Due to anticipated water demand requirements induced by improved water supply facilities and economic growth, it was agreed with the Calgary Regional Planning Commission that a population growth rate of 5% per year was a reasonable growth rate to use in the projections. In fact, the projected population shown in Table 3.8, prepared by Engineering Canada Associates, has already been accepted by the Town of Trochu's Council.

Table 3.9
Future Population

Year	Population
1979	852
1980	895
1985	1,142
1990	1,457
1995	1,860
2000	2,374
2020	6,299

3.3.3 Water Consumption

Future water demand requirements were based on the information obtained from the Town of Trochu. The Town estimates the present water consumption to average approximately 79 gallons per capita per day.

Since the Town of Trochu has the same characteristics as the Town of Three Hills, an increase of 1 gallon per capita per day was assumed.

3.3.4 Peaking Factors

The Town of Trochu estimates that the maximum demand is approximately 140 gallons per day based on past experience. Due to lack of past records this information was accepted without further investigations. From this information the peaking factor for a typical maximum day is estimated to be 1.8; therefore, a peaking factor of 2 is used. The projected water demand requirements are summarized in Table 3.10.

Table 3.10
Future Population and Projected
Water Demand, Town of Trochu

Year	Population	Average Day Demand gcd	Average Day Demand mgd	Maximum Day Demand mgd
1979	852	79	0.07	0.14
1980	895	80	0.07	0.14
1985	1,142	85	0.10	0.20
1990	1,457	90	0.13	0.26
1995	1,860	95	0.18	0.36
2000	2,374	100	0.24	0.48
2020	6,299	110	0.69	1.38

gcd = gallons per capita per day
mgd = million gallons per day

3.3.4 Treated Water Storage Requirements

The analysis for treated water storage requirements show that the Town of Trochu requires 570,000 gallons of storage, as indicated in Table 3.11, to satisfy hourly fluctuations and provide fire protection to the year 2000. Presently, the Town has a total treated water storage capacity of 550,000 gallons which is considered adequate.

Table 3.11
Treated Water Storage Requirements

Year	Fire[1] Flow Reserve mg	Operation[2] Storage mg	Emergency[3] Reserve mg	Total Storage Required With Emergency mg	Total Storage Required Without Emergency mg
1980	0.45	0.04	0.07	0.56	0.49
2000	0.45	0.12	0.24	0.81	0.57

Notes:

(1) Fire flows were calculated at the rate of 2,500 gallons per minute for a 3-hour fire duration.

(2) An allowance in the amount of 25% of maximum daily demand has been provided to allow for hourly demand fluctuation in excess of the peak day demand.

(3) Emergency storage is normally provided in water engineering practice to take care of uncontrollable breakdowns of major components in water supply and treatment facilities. However, for small rural towns, this component is considered a luxury, and therefore it is not considered critical in this case.

3.4 Regional Water Supply

Table 3.12, which follows directly, summarizes the future population and projected water demand for a regional water supply system.

Table 3.12
Future Population and Projected
Water Demand, Regional Water Supply

	Population				Average Day Demand				Maximum Day Demand			
Year	Drumheller	Three Hills[1]	Trochu	Total	Drumheller mgd	Three Hills mgd	Trochu mgd	Total mgd	Drumheller mgd	Three Hills mgd	Trochu mgd	Total mgd
1979	6,573	3,543	852	10,968	0.66	0.20	0.07	0.93	1.65	0.40	0.14	2.19
1980	6,770	3,656	895	11,321	0.70	0.24	0.07	1.01	1.86	0.47	0.14	2.47
1985	7,848	4,297	1,142	13,287	1.22	0.30	0.10	1.62	2.62	0.60	0.20	3.42
1990	9,099	5,097	1,457	15,653	1.50	0.39	0.13	2.02	3.32	0.78	0.26	4.36
1995	10,548	6,099	1,860	18,507	1.85	0.50	0.18	2.53	4.19	0.99	0.36	5.54
2000	12,228	7,330	2,374	21,932	2.28	0.64	0.24	3.16	5.27	1.28	0.48	7.03
2020	22,085	11,015	6,299	39,399	5.21	1.08	0.69	6.98	12.59	2.16	1.38	16.13

Note:

(1) Three Hills' population includes Ruarkville, Grantville and the Prairie Bible Institute.

mgd = million gallons per day

Based on the projected water demands for a regional water supply system, we recommend that the proposed water supply facilities be designed for the following capacities:

	Design Capacity	Design Year
Raw Water Intake	16.13 mgd = 11,201 Igpm	2020
Raw Water Pumphouse	7.03 mgd = 4,882 Igpm	2000
Raw Water Storage Reservoir*	95 mg	2000
Treatment Facilities	7.03 mgd = 4,882 Igpm	2000
High Lift Facilities	7.03 mgd = 4,882 Igpm	2000
Pipeline to Drumheller	5.27 mgd = 3,660 Igpm	2000
Pipeline to Three Hills	1.76 mgd = 1,222 Igpm	2000
Pipeline from Three Hills to Trochu	0.48 mgd = 330 Igpm	2000

*Average day demand

This results in a 20-year design period for the raw water pumps, raw water storage reservoir, treatment facilities, high lift facilities and pipelines to Drumheller, Three Hills and Trochu and a 40-year design period for the raw water intake which is considered satisfactory for the design of waterworks supply facilities.

4.0 PROPOSED WATER SUPPLY FACILITIES

4.1 General

For the purpose of this study we have used the recommended alternatives to supply water to the City of Drumheller and the Town of Three Hills as described in our reports, "City of Drumheller, Water Supply Study" (February 1980) and "Town of Three Hills, Water Supply Study" (October 17, 1979) respectively. The design capacities for the recommended alternatives are based on projected maximum day demands for the year 2000 except that the raw water intake is based on projected maximum day demands for the year 2020. This results in a 20-year design period which is considered satisfactory for waterworks supply facilities. A description of the recommended alternatives and their design capacities follows directly.

4.2 Individual Community Systems

4.2.1 Drumheller Water Supply

The increasing water demand in the City of Drumheller has made the present treatment and water supply facilities incapable of satisfying even the average demand rates as demonstrated in the February report entitled "City of Drumheller, Water Supply Treatment and Distribution Study."

The mode of operation which involved the blending of heavily suspended load with groundwater is no longer practicable, mainly due to the present high water consumption rates and future demand rates. It is impossible to augment the existing water treatment plant due to physical limitations at the site. In order to ensure a reliable water supply for the City of Drumheller,

the river suspended load is to be avoided when it exceeds 1000 milligrams per litre. To achieve this condition, offstream storage appears to be the only economical solution which would reduce the heavy concentration of suspended solids before the raw water is treated. A water balance analysis indicates that some 20 to 40 acres of land would be required to construct the required offstream storage pond to impound approximately 80 to 163 million gallons of raw water. Furthermore, it has been established from design criteria guidelines that the present treatment components are currently overtaxed and cannot be operated at the projected water demand rates.

The implementation of the program which would provide long term reliable water supply and treatment facilities as shown in Plate 4.1 for the City of Drumheller may take up to three years. To satisfy the short term needs, the City has two options by which the water requirements for the next three years could be met. The first was to do nothing and ration water, while the second was to undertake some short term improvements to the groundwater supply. Since the City did not favor rationing, some short term remedial measures were necessary before long term plans could be put in hand. In summary, the action plan has been identified as follows:

Interim Measures (1980 to 1983)

- Well drilling, well pumps and interconnecting piping to the existing water treatment plant. It is anticipated that well production would yield approximately 1,100 gallons per minute (1.6 mgd). This volume of water would be supplemented by river water to bring the total to approximately 1,646 gallons per minute (2.37 mgd). The work involved will be completed towards the end of 1980.

DRUMHELLER SYSTEM

PLATE NO. 4.1

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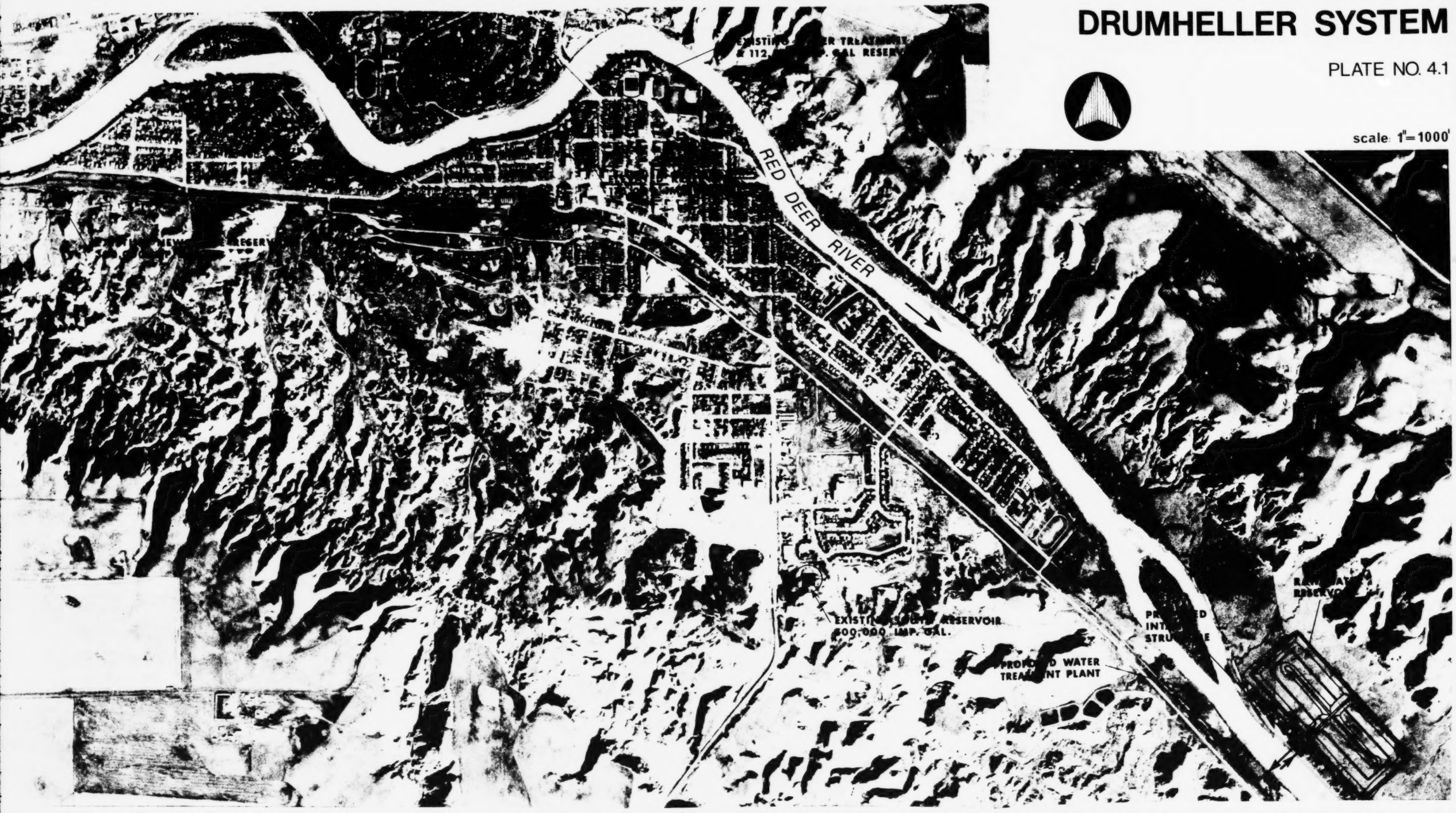

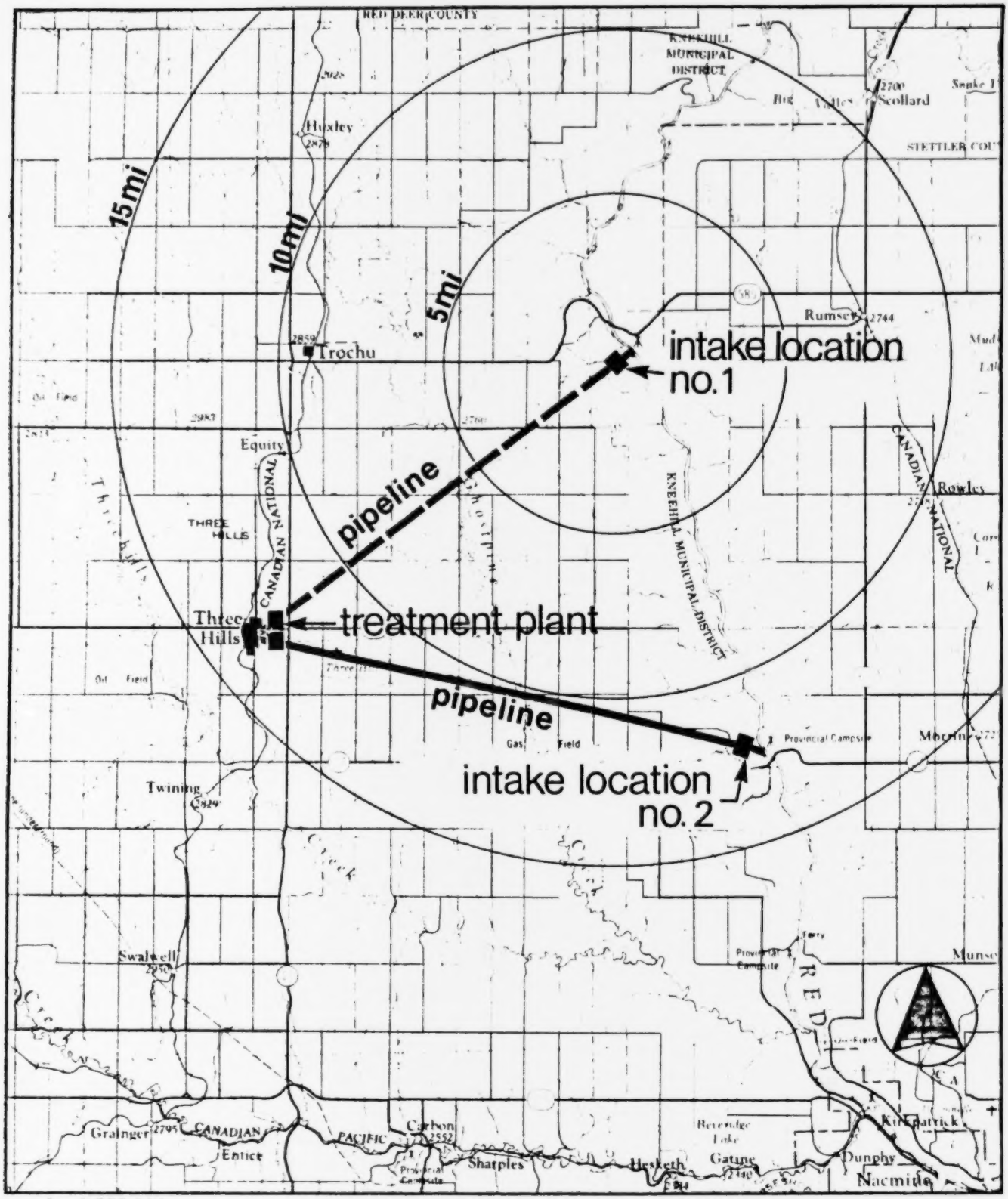

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THREE HILLS SYSTEM

(FROM RED DEER RIVER)

PLATE NO. 4.2

Immediate Measures (1980 to 2000)

These measures essentially form the first stage of the long range plans. They are required to be undertaken concurrently with interim measures. Immediate measures consist of the following components:

- Improvements to the distribution system including construction of treated water storage reservoirs.

Long Term Measures (1983 to 2000)

Major components include:

- An offstream storage reservoir.
- Retention of the existing intake.
- A raw water pipeline.
- Low lift pumps and a treatment plant.

The major components and their design capacities for the proposed water supply system to supply water to the City of Drumheller are as follows:

Raw Water Intake	12.59 mgd
Raw Water Pumphouse	5.27 mgd (± 75 hp pump capacity)
Raw Water Storage Pond	±80. mg
Treatment Plant	5.27 mgd
High Lift Facilities	5.27 (± 360 hp pump capacity)
Pipeline to Distribution System	5.27 (20 inch diameter pipe)

4.2.2 Three Hills Water Supply from Red Deer River

As indicated within our report for the Town of Three Hills, it has been recommended that a raw water intake, a raw water storage pond and a raw water pump station will

be constructed at the Red Deer River (see Plate 4.2). The raw water will be pumped from the Red Deer River to a treatment plant located close to Three Hills. A brief description of the major components and their proposed design capacities for this alternative are:

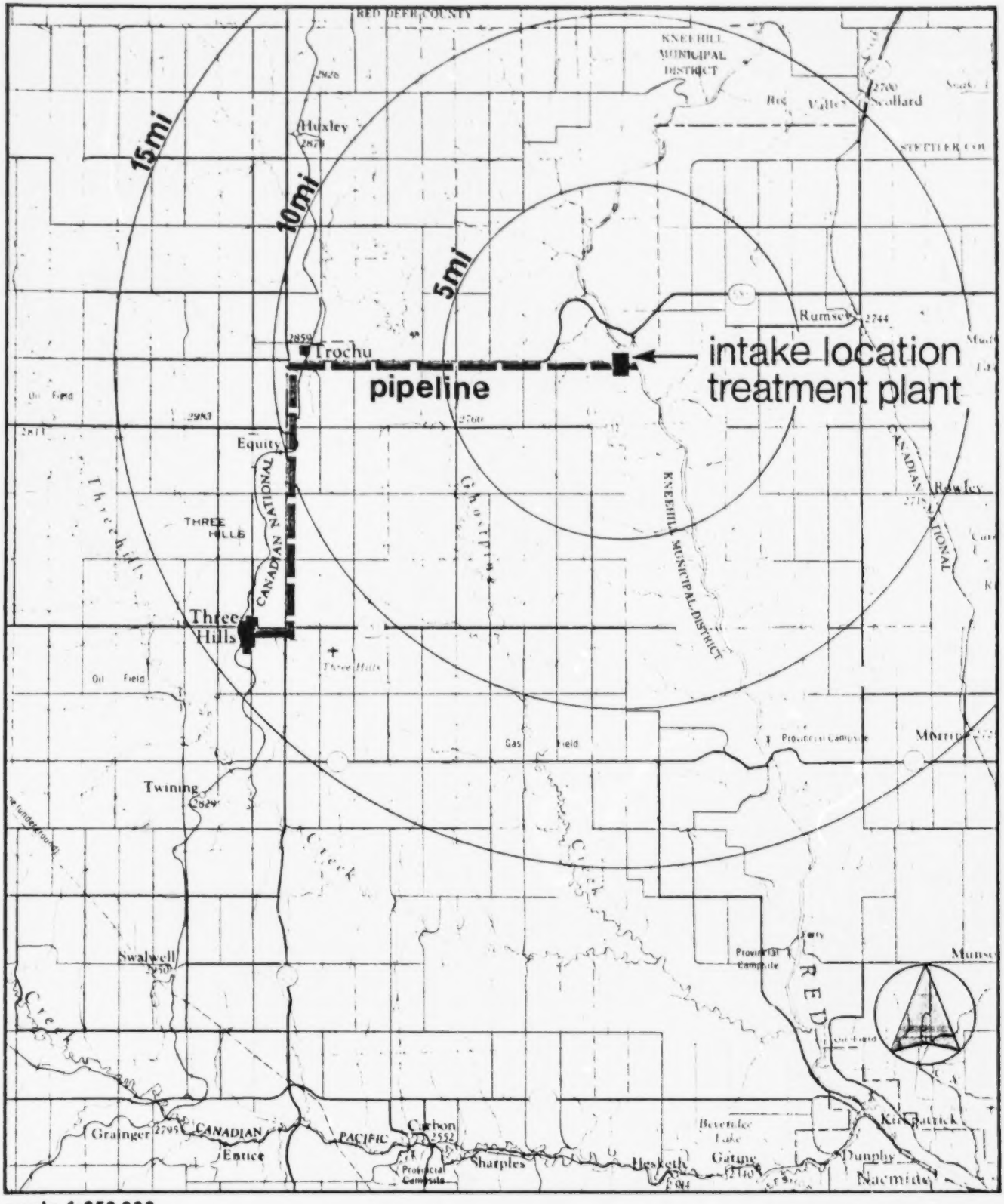
Raw Water Intake	2.16 mgd
Raw Water Pumphouse	1.28 mgd (± 20 hp pump capacity)
Raw Water Storage Pond	±22. mg
High Lift Pump Station	1.28 mgd (± 400 hp pump capacity)
Pipeline from Red Deer River to Three Hills	1.28 mgd (16 inch diameter pipeline)
Treatment Plant	1.28 mgd

4.2.3 Three Hills and Trochu Water Supply from Red Deer River

As a result of the Three Hills Water Supply Study and the knowledge of water supply shortages in Trochu, a "mini" regional water supply system could be developed by building a raw water intake, raw water storage pond, treatment plant and high lift facilities at the intersection of Highway 585 with the Red Deer River and routing the pipeline along Highway 585 to Trochu and south along Highway 21 to Three Hills (see Plate No. 4.3). It is recommended that for this "mini" regional water supply system the raw water and treatment facilities be located at the Red Deer River to maintain all facilities at one location. The major components and their design capacities for a "mini" regional water supply system to supply water to Trochu and Three Hills are as follows:

Raw Water Intake	3.54 mgd
Raw Water Pumphouse	1.76 mgd (± 25 hp pumping capacity)
Raw Water Storage Pond	± 27 mg*
Treatment Plant	1.76 mgd

*See page 4.1 basis of determining raw water for storage pond size.



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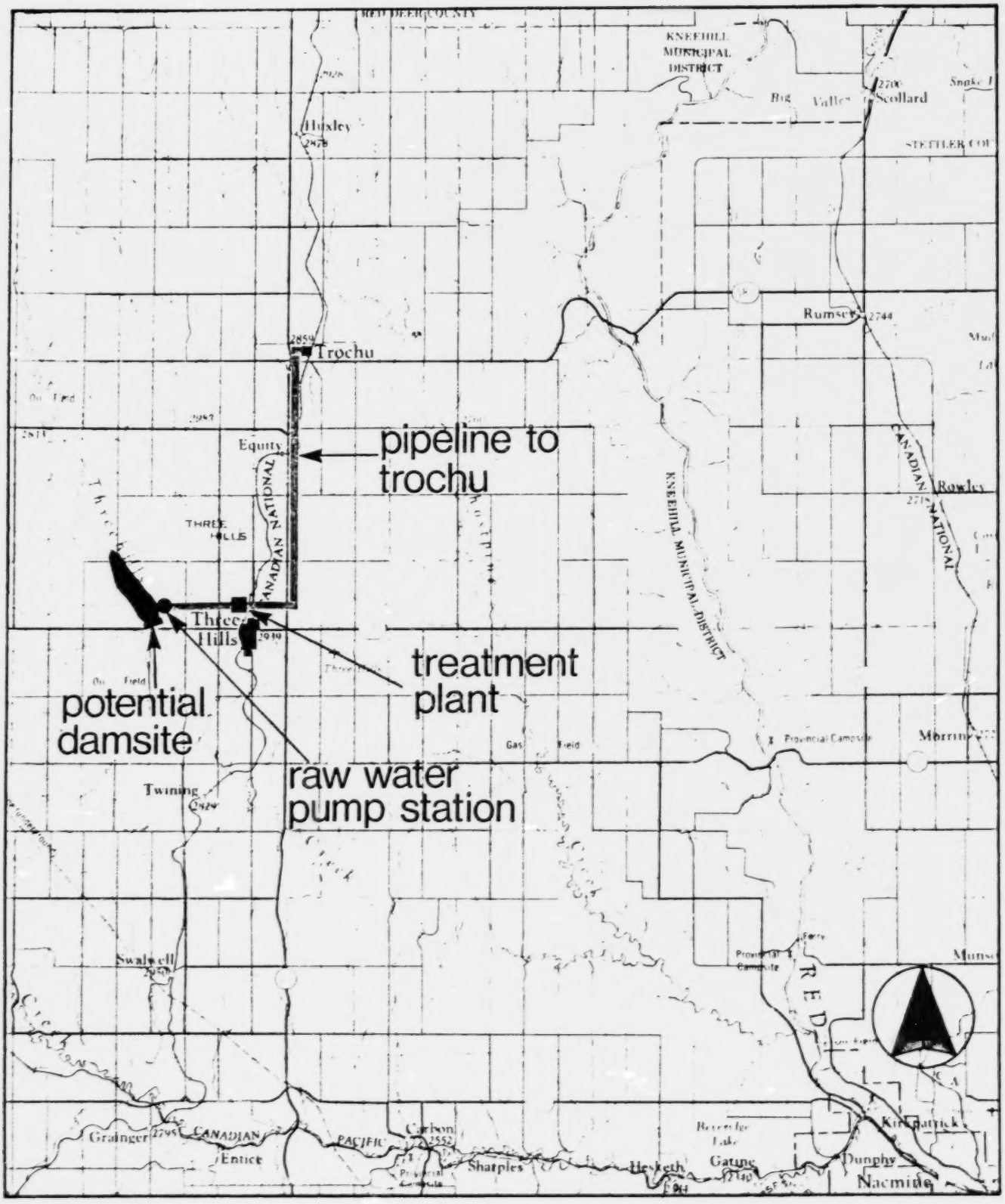
THREE HILLS-TROCHU SYSTEM

(FROM RED DEER RIVER)

PLATE NO. 4.3



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THREE HILLS–TROCHU SYSTEM

(FROM THREE HILLS CREEK)

PLATE NO. 4.4

High Lift Facilities	1.76 mgd (± 550 hp pumping capacity)
Pipeline from Red Deer River to Trochu	1.76 mgd (16 inch diameter pipeline
Pipeline from Trochu to Three Hills	1.28 mgd (14 inch diameter pipe)

4.2.4 Three Hills and Trochu Water Supply from Three Hills Creek

Underwood McLellan Ltd.'s report of 1979 submitted to the Town of Three Hills, determined that the flow characteristics of Three Hills Creek are such that a sizable on-stream storage reservoir would be needed to offset both the intermittent nature of the creek flow and also the variation which occurs in annual yield of runoff in the contributory basin. Further discussion is appended in this report in Appendix A. The report suggested a reservoir of 6000 ac.ft. storage capacity to provide for back-to-back low runoff years, each of 1:25 low flow occurrence. Subsequent water balance shows that a 7500 ac.ft. reservoir would be needed for Three Hills and Trochu water supply "Mini" regional scheme to withstand two successive years of 1:25 magnitude low runoffs.

The overall scheme is outlined as follows (see Plate 4.4):

Storage Pond	7,500 ac.ft.
Raw Water Pumping Station	1.76 mgd (± 100 hp pumping capacity)
Treatment Plant	1.76 mgd
High Lift Facilities	1.76 mgd (± 150 hp pumping capacity)
Pipeline from Three Hills Creek to Treatment Plant	1.76 mgd (14 inch diameter pipe)
Pipeline from Treatment Plant to Trochu	0.48 mgd (8 inch diameter pipe)

4.2.5 Three Hills and Trochu Water Supply - Offstream Storage in Trochu

This water supply scheme considers a raw water storage pond located in Trochu. Raw water would be drawn from the Red Deer River and pumped into an offstream storage located in Trochu. A reservoir in Trochu is sized to supply the maximum month demand through the summer months plus net evaporation losses, plus sufficient storage for the 22 days when the river suspended load is high and river pumps are switched off. A full discussion of the sizing of the pond is contained in Appendix B.

The required storage is 29.66 million gallons. All other components of the water supply system are:

- intake and pump station;
- wet well and high lift pumping;
- pipeline to Trochu from the River high lift pumping station;
- offstream storage in Trochu;
- treatment plant in Trochu;
- pipeline to Three Hills from Trochu.

4.3 Regional Water Supply System

4.3.1 General

Since the existing water supply systems of Drumheller, Three Hills and Trochu require upgrading, it is imperative to investigate the feasibility of a regional water supply system for these communities. The following is a description of the proposed facilities for such a supply system.

4.3.2 Location

A visual field inspection performed by our office along the Red Deer River indicates that the most feasible site for the construction of raw water supply and treatment facilities for a regional water supply system is on the west bank of the river immediately north of Munson Ferry. Munson Ferry is located approximately 12 miles upstream of Drumheller. The site is easily accessible from Highway No. 837 and lies above the floodplain for the Red Deer River. The present land use for the proposed site, as far as can be determined, is agricultural (pastureland). The site is large enough to accommodate future expansion of the facilities beyond the twenty year design period if required. The site is shown on Plate 4.5.

4.3.3 Treatment Facilities

The proposed water treatment unit processes have been based on the available raw water quality information and jar tests undertaken on river water samples at Drumheller.

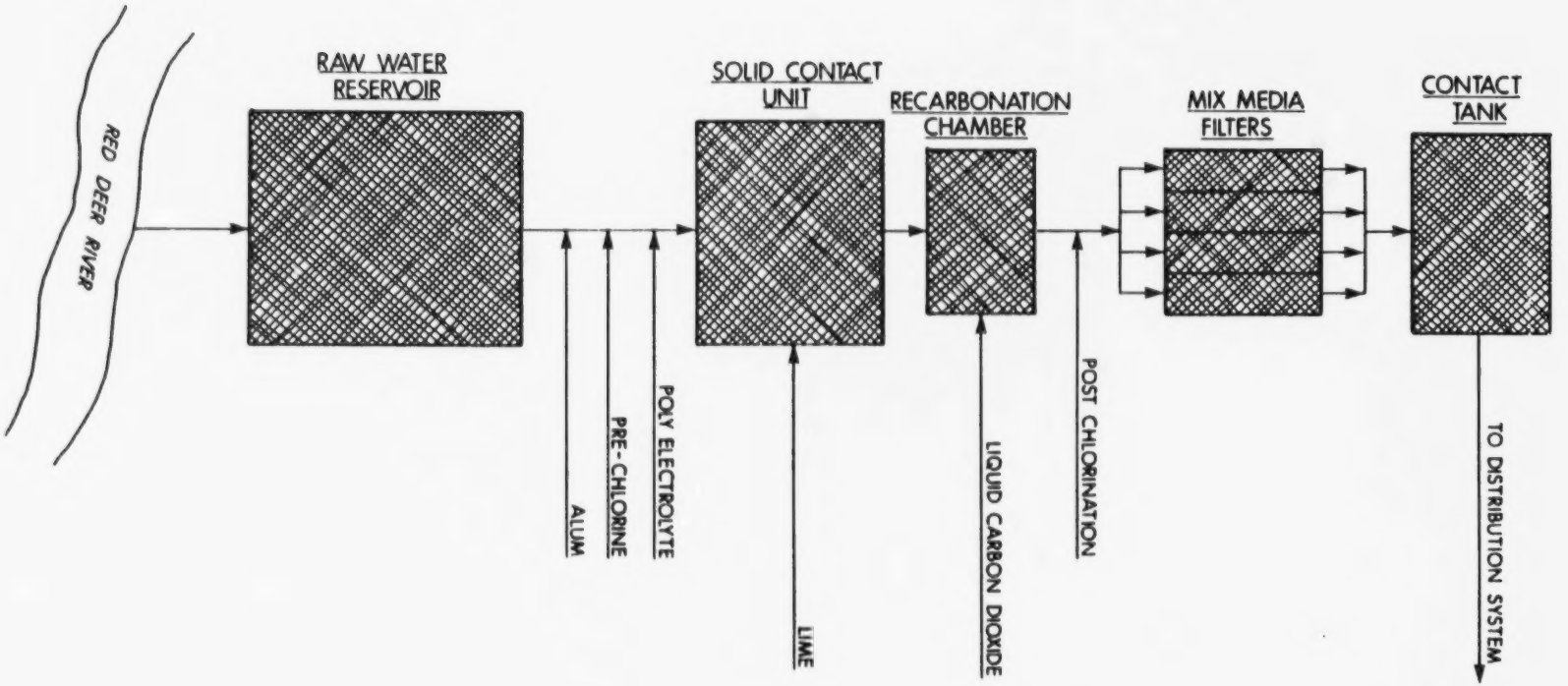
Essentially, the required treatment process involves: sedimentation of settleable discrete particles; coagulation-flocculation in a solids contact unit, filtration, and disinfection in a contact tank. The entire process is depicted in a schematic flow diagram shown in Plate No. 4.6. This process is designed to remove objectionable be matter and render the treated water safe for human consumption.

The overall components of the treatment plant are:

- sedimentation pond
- pre-post chlorination
- solids contact basin

PROPOSED RIVER INTAKE & STORAGE SITE

PLATE NO. 4.5 - SCALE 1:16 000



TREATMENT PLANT FLOW DIAGRAM

PLATE NO. 4.6

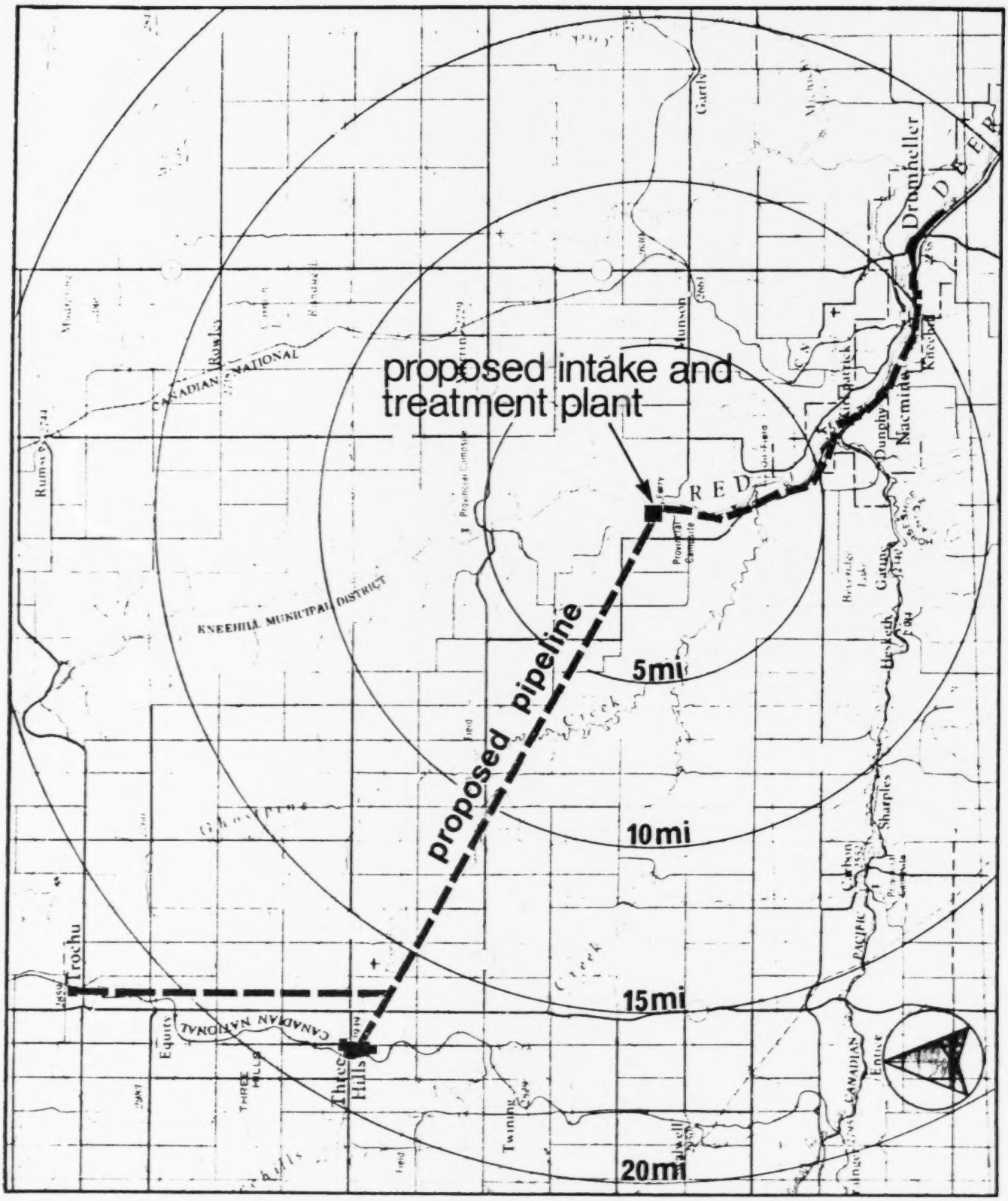
- filters with air scour and surface wash
- treated water clearwell
- high lift pumping
- sludge ponds

Pipeline Route Selection and Pipeline Materials

The approximate pipeline routes from the proposed treatment plant to Drumheller, Three Hills and Trochu are shown on Plate No. 4.7. A considerable amount of detailed topographical surveys and study of land ownership are required to determine final pipeline routes. Highway crossings and railway crossings will be designed in accordance with Alberta Transportation and applicable railway regulations. Depending on the topographical survey and study of land ownership, the pipeline routes as shown on Plate No. 4.7 could vary slightly.

For the purpose of this study, we have assumed that the 24-inch diameter pipeline from the proposed treatment plant to Drumheller will follow on the west bank of the Red Deer River south to Highway No. 837, along Highway No. 837 south to Highway No. 575 and along Highway No. 575 to Drumheller. The approximate length of this route is 65,000 linear feet (12.3 miles). Maximum system pressure at the treatment plant is anticipated to be approximately 70 psi. It is recommended to use reinforced concrete pressure pipe for this pipeline.

Approximately 93,000 linear feet (17.6 miles) of 16-inch diameter pipeline, from the proposed treatment plant to the intersection of Highway No. 583 and Highway No. 21 east of Three Hills, is required to transport water to Three Hills. The maximum anticipated system pressure at the treatment plant is approximately 500 psi and for the purpose of estimating costs, it has been assumed that a



scale 1:250,000

REGIONAL SYSTEM

PLATE NO. 4.7

yellow jacketed, epoxy lined steel pipe will be installed. It is suggested to locate a treated water storage reservoir at the end of this pipeline for hydraulic reasons and to re-pump water through an approximate 47,000 linear foot (8.9 mile) long 8-inch diameter pipeline along Highway No. 21 from Three Hills to Trochu. Maximum system pressure for this pipeline is anticipated at 50 psi and it is suggested to use polyethylene or polyvinyl chloride pipe.

A contingency sum has been included in the estimated pipeline costs to provide for additional pipeline length due to highway crossings, railway crossings and corrosion protection, if necessary.

Summary of Proposed Facilities

The major components and their recommended design capacities for a regional water supply system to supply water to the City of Drumheller, the Town of Three Hills and the Town of Trochu are as follows:

- Raw Water Intake	16.13 mgd
- Raw Water Pumphouse	16.13 mgd
- Raw Water Storage Pond	95 mg
- Treatment Plant and High Lift Pumps	7.03 mgd

4.4 Operation of Regional Water Supply Facilities

4.4.1 Raw Water Intake

Raw water would be pumped into the 95 million gallon offstream storage during periods when the river suspended load concentration is less than 1000 milligrams per litre. Intake pumps would be switched off during periods of high

suspended solids concentration and raw water would be obtained from the impounded reservoir. Control of low lift pumps will be initiated by a suspended solids transmitter.

4.4.2 High Lift Pumping

Suitable pumps will deliver treated water to Drumheller and Three hills - Trochu pipelines at selected total dynamic heads. Suitable valves and piping will be installed to provide protection against water hammer. Control of pumps to Drumheller and Three Hills - Trochu will be by telemetering level control mechanism. The details of an optimum pump control scheme will be finalized at predesign stage.

4.4.3 Treated Water Storage Reservoirs

It is intended to install level transmitters at each major treated water storage reservoir for Drumheller central reservoir and Three Hills reservoir.

For the Drumheller water supply scheme, treated water would be pumped via a 24-inch diameter pipeline to a central reservoir located at the existing treatment plant. From the central reservoir in Drumheller, booster pumps would deliver via the distribution system into the elevated storage reservoirs which would be controlled by level transmitters located at each reservoir.

For the Three Hills - Trochu scheme, a similar control mechanism is envisaged.

4.4.4 Integration of Individual Existing Water Supply Systems With the Regional Scheme

Drumheller

It is considered prudent to retain the existing facilities to provide emergency backup and reduce peak hourly pumping load on the new facilities. In any case the proposed central reservoir will require high lift pumps which would conveniently be connected to the existing electric supply lines.

Three Hills - Trochu Scheme

In order to reduce power use at the new high lift pumping station it is intended to retain the existing facilities in Three Hills and Trochu as long as they are in working order. These old facilities will be utilized as either back-up emergency systems or as peaking plants, hence reduce pumping from the regional high lift pumping station.

5.0 ESTIMATED COSTS

5.1 General

Capital Costs

The following estimated costs for various proposed water supply facilities are based on current 1980 prices and include a sum for engineering and contingencies, but they do not include any cost for additional treated water storage and distribution system improvements.

Operation and Maintenance Costs

Maintenance costs have been estimated at 0.50% of capital costs for both civil and mechanical work. It must be noted that annual operational costs will vary according to both demand and general cost escalation, therefore, they are difficult to relate meaningfully to capital costs. Operating costs shown are in 1980 dollars.

Staging of Various Water Supply Components

The implementation of the proposed various sytem components will be staged wherever an opportunity for staging exists, and such items have been identified in the cost estimates.

Table 5.1
Preliminary Cost Estimate
City of Drumheller

Item		Estimated Cost Stage I 1980-1990	Stage II 1990-2000
1	Land Acquisition	$540,000	-
2	River Intake Structure, Raw Water Pumps plus Associated Pipelines	$645,000	$40,000
3	Off-stream Storage plus Interconnecting Piping	$1,050,000	-
4	Raw Water Wet Well plus Low Lift Pumps	$520,000	$40,000
5	Treatment Plant	$4,055,000	$290,000
6	High Lift Pumping Station plus Clearwell	$320,000	$50,000
7	Sludge Ponds plus Piping	$75,000	-
8	20-inch Pipeline from Treatment Plant to Distribution System	$400,000	-
9	Power Supply	$100,000	-
10	Site Surveys, Legal, Administration and Interim Finance	$310,000	-
TOTALS		$8,015,000	$420,000
		$8,435,000	

Source: Red Deer River

Table 5.2
Preliminary Operating Costs[1]
City of Drumheller

	1980	1985	1990	1995	2000
1. General Maintenance Cost	$ 40,075	$ 40,075	$ 42,175	$ 42,175	$ 42,175
2. Power Costs	23,200	31,600	40,900	51,200	63,900
3. Chemicals	18,100	22,250	27,350	33,740	41,580
4. Labour and Administration	56,000	56,000	56,000	56,000	56,000
TOTAL ESTIMATED OPERATING COSTS	$137,375	$149,925	$166,425	$183,115	$203,655

Notes:

(1) Based on 1980 dollars.

5.2 Three Hills Water Supply from Red Deer River

The estimated capital and operating costs for the recommended alternative to supply water to Three Hills are shown on Tables 5.3 and 5.4.

Table 5.3
Preliminary Cost Estimate
Town of Three Hills
Water Supply from Red Deer River

Item		Estimated Cost Stage I 1980-1990	Stage II 1990-2000
1	Land Acquisition	$161,000	-
2	River Intake Structure, Raw Water Pump Station plus Associated Pipelines	$180,000	$20,000
3	Off-stream Storage plus Interconnecting Piping	$250,000	-
4	Raw Water Low Lift Pumps	$90,000	$10,000
5	High Lift Pumping Station (Raw Water) Wet Well plus Structure	$750,000	$60,000
6	Pipeline from River to Treatment Plant	$2,880,000	-
7	Power Supply	$220,000	-
8	Treatment Plant	$1,440,000	$110,000
9	High Lift Pumping plus Clearwell	$130,000	$30,000
10	Sludge Ponds plus Piping	$20,000	-
11	Site Surveys, Legal, Administration and Interim Finance	$240,000	-
TOTALS		$6,361,000	$230,000
		$6,591,000	

Table 5.4
Preliminary Operating Costs(1)
Town of Three Hills
Water Supply from Red Deer River

	1980	1985	1990	1995	2000
1. General Maintenance Cost	$ 31,805	$ 31,805	$ 32,955	$ 32,955	$ 32,955
2. Power Costs	24,400	31,000	39,800	51,600	65,300
3. Chemicals	4,010	5,300	6,930	8,950	11,670
4. Labour and Administration	52,000	52,000	52,000	52,000	52,000
TOTAL ESTIMATED OPERATING COSTS	$112,215	$120,105	$131,685	$145,505	$161,925

Note:

(1) Based on 1980 dollars.

5.3 Three Hills and Trochu Water Supply from Red Deer River

The estimated capital and operating costs for a "Mini" Regional Water Supply System for Three Hills and Trochu are shown on Tables 5.5 and 5.6 which follow directly.

Table 5.5
Preliminary Cost Estimate
Town of Three Hills and Town of Trochu
Water Supply From Red Deer River

Item		Estimated Cost Stage I 1980-1990	Stage II 1990-2000
1	Land Acquisition	$203,000	-
2	River Intake Structure, Raw Water Pumping and Associated Pipes	$200,000	$20,000
3	Off-stream Storage plus Interconnecting Piping	$310,000	-
4	Raw Water Low Lift Pumps	$100,000	$10,000
5	Treatment Plant	$1,830,000	$170,000
6	High Lift Pumping Station plus Clearwell	$160,000	$40,000
7	Sludge Ponds and Piping	$20,000	-
8	Pipeline from River to Trochu	$1,938,000	-
9	Pressure Reducing Station at Trochu	$75,000	-
10	Pipeline from Trochu to Three Hills	$1,645,000	-
11	Power Supply	$225,000	-
12	Site Surveys, Legal, Administration and Interim Financing	$260,000	-
TOTALS		$6,966,000	$240,000
		$7,206,000	

Table 5.6
Preliminary Operating Costs[1]
Town of Three Hills and Town of Trochu
Water Supply from Red Deer River

	1980	1985	1990	1995	2000
1. General Maintenance Cost	$ 34,830	$ 34,830	$ 36,030	$ 36,030	$ 36,030
2. Power Costs	25,400	33,900	44,300	57,900	75,900
3. Chemicals	5,290	7,120	9,300	12,220	16,050
4. Labour and Administration	53,000	53,000	53,000	53,000	53,000
TOTAL ESTIMATED OPERATING COSTS	$118,520	$128,850	$142,630	$159,150	$180,980

Note:

Based on 1980 dollars.

5.4 Three Hills and Trochu Water Supply From Three Hills Creek

Tables 5.7 and 5.8, which follow directly, show the estimated capital and operating costs for a "mini regional" water supply system for Three Hills and Trochu from Three Hills Creek.

Table 5.7
Preliminary Cost Estimate
Town of Three Hills & Town of Trochu
Water Supply from Three Hills Creek

Item		Estimated Cost Stage I 1980-1990	Stage II 1990-2000
1	Land Acquisition ((dam site and associate facilities, reservoir area, pipeline right-of-way)	$945,000	-
2	Provision for Farmstead Purchase or Protection	$635,000	-
3	Dam Construction - Earthfill dam with maximum height of 30 feet (stripping, borrow excavation, compacted embankment, rip-rap slope protection, etc.)	$835,000	-
4	Service Spillway - Concrete Chute Drop	$490,000	-
5	Dam Low Level Outlet and Reservoir Intake	$105,000	-
6	Raw Water Pumping Station	$210,000	$40,000
7	Pipeline from Three Hills Creek to Treatment Plant	$577,500	-
8	Possible Modification and Protection of Secondary Highway #583	$250,000	-
9	Water Treatment Plant	$1,630,000	$170,000
10	High Lift Pumping Station (at Treatment Plant) to Three Hills and Trochu	$160,000	$40,000
11	Pipeline from Three Hills to Trochu	$884,000	-
12	Power Supply	$100,000	-
13	Site Surveys, Legal, Administration and Interim Finance	$260,000	-
TOTAL ESTIMATED CAPITAL COSTS		$7,081,500	$250,000
		$7,331,500	

Table 5.8
Preliminary Operating Costs(1)
Town of Three Hills & Town of Trochu
Water Supply from Three Hills Creek

	1980	1985	1990	1995	2000
1. General Maintenance Cost	$ 35,400	$ 35,400	$ 36,660	$ 36,660	$ 36,660
2. Power Costs	11,700	15,300	20,000	25,700	33,000
3. Chemicals	5,290	7,120	9,300	12,220	16,050
4. Labour and Administration	53,000	53,000	53,000	53,000	53,000
TOTAL ESTIMATED OPERATING COSTS	$105,390	$110,820	$118,960	$127,580	$138,710

Note:

(1) Based on 1980 dollars.

5.5 Regional Water Supply

The estimated capital and operating costs for a Regional Water Supply System to supply water to Drumheller, Three Hills and Trochu are shown on Table 5.9 and 5.10 which follow directly.

Table 5.9
Preliminary Cost Estimate
Regional Water Supply

Item		Estimated Cost Stage I 1980-1990	Stage II 1990-2000
1	Land Acquisition	$392,000	-
2	River Intake Structure, Raw Water Pumps plus Associated Piping	$230,000	$40,000
3	Off-stream Storage plus Interconnecting Piping	$1,050,000	-
4	Raw Water Low Lift Pumps	$170,000	$40,000
5	Treatment Plant	$4,420,000	$330,000
6	High Lift Pumping Station plus Clearwell	$400,000	$100,000
7	Sludge Ponds plus Piping	$85,000	-
8	Pipeline from Treatment Plant to Drumheller	$3,250,000	-
9	Pipeline from Treatment Plant to Three Hills	3,534,000	-
10	Pumping Station at Three Hills	75,000	-
11	Pipeline from Three Hills to Trochu	$799,000	-
12	Power Supply	$250,000	-
13	Site Surveys, Legal, Administration and Interim Financing	$460,000	-
TOTALS		$15,115,000	$510,000
		$15,625,000	

Table 5.10
Preliminary Operating Costs[1]
Regional Water Supply

	1980	1985	1990	1995	2000
1. General Maintenance Cost	$ 75,580	$ 75,580	$ 78,130	$ 78,130	$ 78,130
2. Power Costs	44,800	61,500	79,600	102,300	133,980
3. Chemicals	23,160	29,360	36,700	45,960	57,600
4. Labour and Administration	56,000	56,000	56,000	56,000	56,000
TOTAL ESTIMATED OPERATING COSTS	$199,540	$222,440	$250,430	$282,390	$325,710

Note:

(1) Based on 1980 dollars

5.6 Three Hills and Trochu Water Supply from Red Deer River with Raw Water Storage Reservoir Located at Trochu

The estimated capital and operating costs for a "mini" regional water supply system to supply water to Three Hills and Trochu from the Red Deer River with the raw water storage reservoir located at Trochu are shown on Table 5.11 and 5.12.

Table 5.11
Preliminary Cost Estimate
"Mini Regional System from Red Deer River
with Raw Water Storage at Trochu

Item		Estimated Cost Stage I 1980-1990	Stage II 1990-2000
1	Land Acquisition	$250,000	-
2	River Intake Structure, and Associated Pipes	$200,000	$20,000
3	Wet Well with High Lift Pumps plus Control Equipment	$825,000	$170,000
4	Off-stream Storage in Trochu plus Interconnecting Piping	$280,000	-
5	Sludge Ponds and Piping	$75,000	-
6	Raw Water Low Lift Pumps to the Treatment Plant	$100,000	$20,000
7	Treatment Plant	$1,830,000	$170,000
8	Pipeline from River to Trochu (16" dia steel pipe cement mortar lined)	$1,938,000	
9	Pipeline from Trochu to Three Hills	$1,645,000	-
10	Power Supply	$225,000	-
11	Site Surveys, Legal, Administration and Interim Financing	$260,000	-
TOTALS		$7,628,000	$380,000
		$8,008,000	

Table 5.12
Preliminary Operating Costs(1)
"Mini" Regional System from Red Deer River
With Raw Water Storage at Trochu

	1980	1985	1990	1995	2000
1. General Maintenance Cost	$ 38,140	$ 38,140	$ 40,040	$ 40,040	$ 40,040
2. Power Costs	18,720	24,480	32,000	41,120	52,800
3. Chemicals	5,290	7,120	9,300	12,220	16,050
4. Labour and Administration	53,000	53,000	53,000	53,000	53,000
TOTAL ESTIMATED OPERATING COSTS	$115,150	$122,740	$134,340	$146,380	$161,890

Note:

(1) Based on 1980 dollars.

5.7 Summary of Capital and Operating Costs

Table 5.13 and 5.14, which follow directly, shows a summary of the estimated capital and operating costs for the various alternatives to supply water to the communities of Drumheller, Three Hills and Trochu.

Table 5.13
Summary of Preliminary Capital Costs

			"Mini" Regional Systems		
	Drumheller Only	Three Hills Only	From Red Deer River	From Three Hills Creek	Regional System
Stage I 1980-1990	$8,015,000	$6,361,000	$6,966,000	$7,081,500	$15,115,000
Stage II 1990-2000	$ 420,000	$ 230,000	$ 240,000	$ 250,000	$ 510,000
TOTALS	$8,435,000	$6,591,000	$7,206,000	$7,331,500	$15,625,000

Table 5.14
Summary of Preliminary Operating Costs

	1980	1985	1990	1995	2000
Drumheller Only	$137,375	$149,925	$166,425	$183,115	$203,655
Three Hills Only	$112,215	$120,105	$131,685	$145,505	$161,925
Mini Regional from Red Deer River	$118,520	$128,850	$142,630	$159,150	$180,980
Mini Regional from Three Hills Creek	$105,390	$110,820	$118,960	$127,580	$138,710
Mini Regional from Red Deer River - Raw Water Storage at Trochu	$115,150	$122,740	$134,340	$146,380	$161,890
Regional System	$199,540	$222,440	$250,430	$282,390	$325,710

5.8 Summary of Proposed Alternatives

As a result of this study, the following alternatives were identified:

Alternative 1A - Drumheller would have an independent water supply system whereas the communities of Three Hills and Trochu would be supplied by a "Mini" regional water supply system with the Red Deer River as the source of supply. Offstream storage and treatment plant facilities would be located near the river.

Alternative 1B - this system is similar to Alternative 1A with the exception of the source of supply which would be Three Hills Creek for the "Mini" regional supply to Three Hills and Trochu.

Alternative 1C - this system is similar to Alternative 1A with the exception of the location of offstream storage and treatment plant facilities for the "Mini" regional system. These facilities would be located at Trochu instead of being at the Red Deer River.

Alternative 2 - this alternative provides for a regional water supply system to Drumheller, Three Hills and Trochu. Raw Water source would be the Red Deer River and offstream storage and treatment facilities would be located on the west bank of the river - north of Munson's Ferry.

Alternative 3 - this alternative provides independent water supply systems for each of the communities of Drumheller, Three Hills and Trochu.

The following Tables 5.15, 5.16, 5.17, 5.18, 5.19, 5.20, 5.21, 5.22, 5.23 and 5.24 indicate capital and operating costs for these alternatives.

Table 5.15
Total Preliminary Capital Costs
Alternative No. 1A
Independent Facility for Drumheller and "Mini" Regional Water Supply from Red Deer River

	Drumheller Water Supply System	Mini Regional Water Supply System from Red Deer River	Total Capital Costs
Stage I 1980-1990	$8,015,000	$6,966,000	$14,981,000
Stage II 1990-2000	$ 420,000	$ 240,000	$ 660,000
TOTALS	$8,435,000	$7,206,000	$15,641,000

Table 5.16
Total Preliminary Operating Costs[1]
Alternative No. 1A

	1980	1985	1990	1995	2000
Drumheller Water Supply System	$137,375	$149,925	$166,425	$183,115	$203,655
Mini Regional System from Red Deer River	$118,520	$128,850	$142,630	$159,150	$180,980
TOTAL ESTIMATED OPERATING COSTS	$255,895	$278,775	$309,055	$342,265	$384,635

Note:

(1) Based on 1980 dollars

Table 5.17
Total Preliminary Capital Costs
Alternative No. 1B
Independent Facility for Drumheller and "Mini" Regional
Water Supply from Three Hills Creek

	Drumheller Water Supply System	Mini Regional Water Supply System from Three Hills Creek	Total Capital Costs
Stage I 1980-1990	$8,015,000	$7,081,500	$15,096,500
Stage II 1990-2000	$ 420,000	$ 250,000	$ 670,000
TOTALS	$8,435,000	$7,331,500	$15,766,500

Table 5.18
Total Preliminary Operating Costs[1]
Alternative No. 1B

	1980	1985	1990	1995	2000
Drumheller Water Supply System	$137,375	$149,925	$166,425	$183,115	$203,655
Mini Regional System from Red Deer River	$105,390	$110,820	$118,960	$127,580	$138,710
TOTAL ESTIMATED OPERATING COSTS	$242,765	$260,745	$285,385	$310,695	$342,365

Note:

(1) Based on 1980 dollars.

Table 5.19
Total Preliminary Capital Costs
Alternative No. 1C
Independent Facility for Drumheller and "Mini" Regional
Water Supply from Red Deer River with Raw Water Storage at Trochu

	Drumheller Water Supply System	Mini Regional Water Supply System From Red Deer River - Raw Water Storage at Trochu	Total Capital Costs
Stage I 1980-1990	$8,015,000	$7,628,000	$15,643,000
Stage II 1990-2000	$ 420,000	$ 380,000	$ 800,000
TOTALS	$8,435,000	$8,008,000	$16,443,000

Table 5.20
Total Preliminary Operating Costs(1)
Alternative 1C

	1980	1985	1990	1995	2000
Drumheller Water Supply System	$137,375	$149,925	$166,425	$183,115	$203,655
Mini Regional System from Red Deer River - Raw Water Storage at Trochu	$115,150	$122,740	$134,340	$146,380	$161,890
Total Estimated Operating Costs	$252,525	$272,665	$300,765	$329,495	$365,545

Note:

(1) Based on 1980 dollars.

Table 5.21
Total Preliminary Capital Costs
Alternative No. 2
Regional Water Supply System

Stage I - 1980-1990	$15,115,000
Stage II- 1990-2000	$ 510,000
	$15,625,000

Table 5.22
Total Preliminary Operating Costs(1)
Alternative No. 2

1980 Dollars	1980	1985	1990	1995	2000
TOTAL ESTIMATED OPERATING COSTS	$199,540	$222,440	$250,430	$282,390	$325,710

Note: Based on 1980 dollars.

Table 5.23
Total Preliminary Capital Costs
Alternative 3

Independent Water Supply Scheme for:

Drumheller - Raw Water Source - Red Deer River
Three Hills - Raw Water Source - Red Deer River
Trochu - Raw Water Source - (wells)

		Drumheller	Three Hills	Trochu
Stage I	1980-1990	$8,015,000	$6,361,000	$600,000
Stage II	1990-2000	$ 420,000	$ 230,000	(1)
TOTALS		$8,435,000	$6,591,000	$600,000

Note: (1) Not available at time of publication.

Table 5.24
Operating Costs (1)
Alternative No. 3

	1980	1985	1990	1995	2000
Drumheller	$137,375	$149,925	$166,425	$183,115	$203,655
Three Hills	$112,215	$120,105	$131,685	$145,505	$161,925

Note:

(1) Based on 1980 dollars.

The capital costs for the Town of Trochu have not been included because they were unavailable. However, it must be noted that the Town of Trochu is developing an additional well estimated to yield approximately 90 gallons per minute. Furthermore, the Town has a total treated water storage capacity of 550,000 gallons which is considered adequate up to the year 2000 when additional storage may be required.

5.9 Comparative Cost Analysis

The present worth method of analysis is a means of evaluating alternative water supply and treatment alternatives being considered for a community. The zero date used as a basis of comparison is 1980 and all immediate and deferred expenditures (capital and annual operating costs) are expressed as 1980 dollars. A basic assumption of this method is that expenditures of money associated with the construction of future works are estimated on the basis of present day costs. This procedure requires the selection of a discount rate which is an estimate of the effect of interest rates, inflation rates and other factors on future costs.

Alberta Environment's economic costing model was used to determine the present worth for Alternatives 1A, 1B, 1C, and 2. The results of the analysis are summarized in Table 5.25. The model considers the following basic factors:

Impact of Inflation on Construction and Operating Costs:

As shown in Table 5.26, the analysis considers low, medium and high values of interest and inflation rates. The model recognizes the fact that inflation rates can be different for different cost elements, for instance, for energy, labour, mechanical plant, chemicals and materials for construction.

The Time Value of Money:

For engineering projects which involve capital and operating cost expenditures in more than one year, it is essential that the time value of money be considered. The values of interest and inflation rates used in the study are shown in Table 5.26. The analysis produced nine rate structures, a combination of low, medium and high interest rates with corresponding inflation

rates. For the purposes of this study, only the medium rates were used in the economic cost analysis as shown in Tables 5.25.

This analysis indicates that Alternative 2 which is the Regional Water Supply System for Drumheller, Three Hills, Trochu and adjacent communities is the least expensive of the four Alternatives considered.

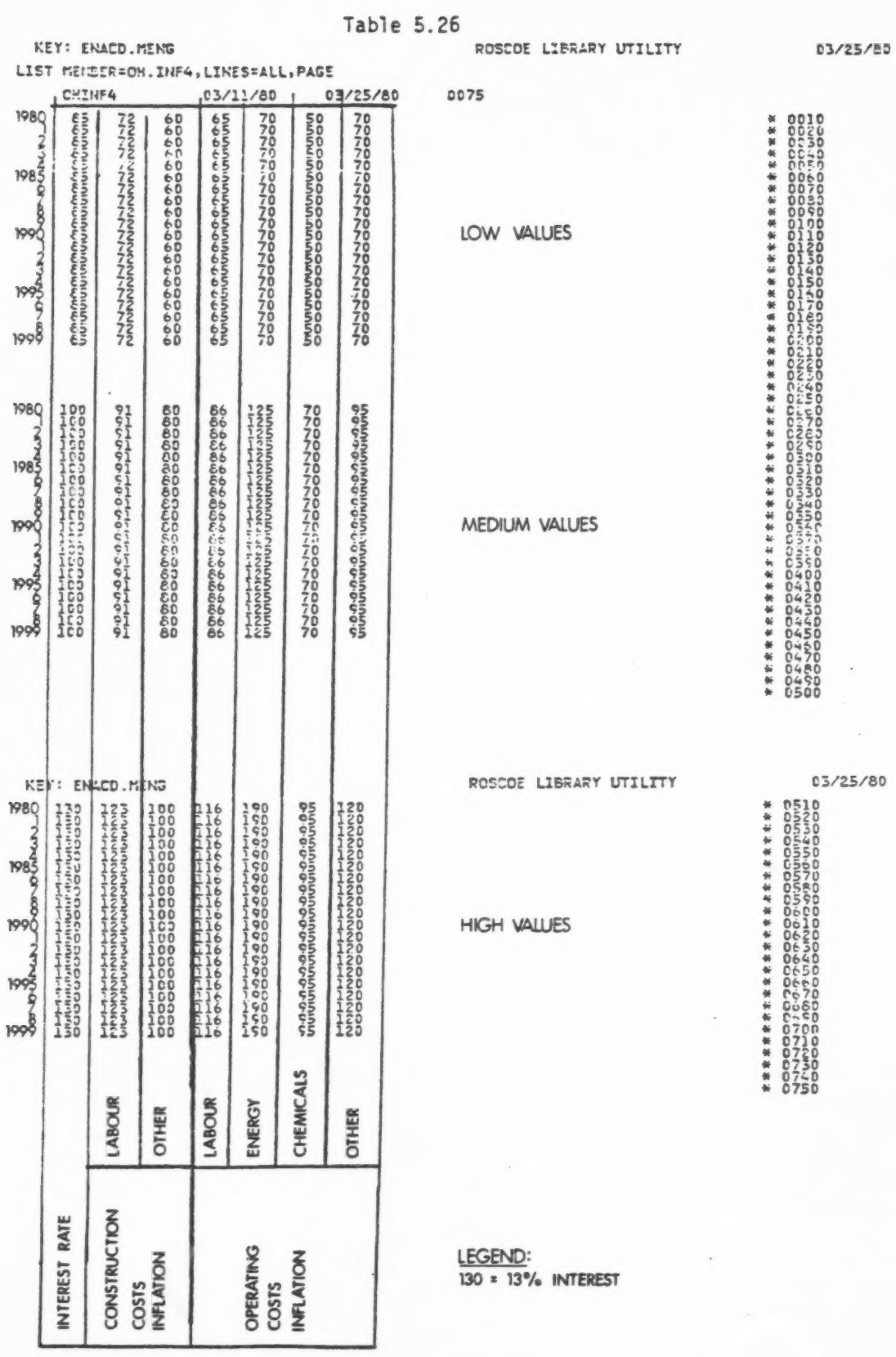
Table 5.25
Present Worth Comparative Cost Analysis of
Regional Water Supply Systems

		Present Worth Based on Medium Net Effective Interest Rates
1A	Drumheller Independent Water Supply System	$11,112,000
	"Mini" Regional - Three Hills and Trochu Water Supply System from Red Deer River; Raw Water Off-stream Storage at the River	$9,628,000
	TOTAL	$20,740,000
1B	Drumheller Independent Water Supply System	$11,112,000
	"Mini" Regional Water Supply Scheme (Three Hills and Trochu) Three Hills Creek - Impounded Reservoir	$9,200,000
	TOTAL	$20,312,000
1C	Drumheller Independent Water Supply System	$11,112,000
	"Mini" Regional Water Supply for Three Hills and Trochu; Sc rce Red Deer River; Off-stream Storage located in Trochu	$10,180,000
	TOTAL	$21,292,000

Table 5.25
(cont'd)

2.	Regional Water Supply System to Drumheller, Trochu and Three Hills; Raw Water Source from Red Deer River	$19,729,000
	TOTAL	$19,729,000
3.	Drumheller Independent Water Supply Scheme	$11,112,000
	Three Hills Independent Water Supply Scheme - Red Deer River Source	8,842,000
4.	Trochu	Information Unavailable at the Time of Publication
	TOTAL	$19,954,000

Table 5.26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OPERATING COSTS INFLATION
LABOUR
ENERGY
CHEMICALS
OTHER
LEGEND:
130 = 13% INTEREST

6. RECOMMENDED PROCEDURES FOR PROJECT IMPLEMENTATION

Following is a list of recommended procedures for implementation of the proposed project:

1. Approval in principle of the report by Alberta Environment.

2. Hold meetings with the communities concerned to explain the regional water supply alternatives evaluated and to obtain a decision on the implementation of a regional water supply system.

3. Commission soils investigation to finalize site selection for offstream storage (raw water) and treatment and pumping facilities.

4. Make application to the Municipal District of Kneehill for a development permit for the proposed water treatment and raw water storage facilities.

5. Arrange for land and easements.

6. Concurrent with item 5, commission engineering design.

7. Complete design and submit to Alberta Environment for approval.

8. Advise communities to prepare necessary by-laws and arrange financing for their portion of the overall debt.

9. Tender transmission mains, water treatment, pumping, intake and raw water storage facilities.

10. Select a contractor and commence construction.

APPENDIX A

THREE HILLS AND TROCHU WATER SUPPLY
FROM THREE HILLS CREEK

Three Hills and Trochu Water Supply from Three Hills Creek

Pond Sizing Analysis

In 1979, Underwood McLellan Ltd. carried out a study for the Town of Three Hills which investigated Three Hills Creek as a possible water supply for the Town. The results of the study were outlined in a report submitted to the Town.

The report determined that the flow characteristics of Three Hills Creek are such that a sizeable on-stream storage reservoir would be needed to offset both the intermittent nature of the creek flow and also the variation which occurs in annual yield of runoff in the contributory basin.

The annual demand of the regional system would, of course, be increased somewhat over that studied in the report as shown in Table A.1.

Table A.1
Mini Regional Supply System
Reservoir Volume for Consumptive Use

	Three Hills	Trochu	Total
2000	860 ac.ft.	322 ac.ft.	1,182 ac.ft.
2020	1,450 ac.ft.	927 ac.ft.	2,377 ac.ft.

Three possible storage sites were identified in the study and are shown in the Appendix. The most northerly (Site No. 1) would be approximately equidistant to Trochu and Three Hills. Site No. 2 is immediately west of Three Hills and north of Secondary Highway No. 583, and the third site is west of Three Hills and south of Secondary Highway No. 583.

In consideration of a regional supply to the two towns, Site No. 2 is probably superior in terms of location in the drainage basin, depth of water per unit area of reservoir and proximity to Three Hills, which is projected to have the largest demand. However, in the final analysis, securement of the land required for the reservoir may be the factor which decides the location.

The Three Hills report suggested a reservoir of 6,000 acre feet storage capacity to provide for back-to-back low runoff years, each of 1:25 low flow occurrence. Year 2020 demands, considering withdrawals, net evaporation and seepage, were estimated at 2,175 acre feet. For the Trochu - Three Hills Regional Supply, the equivalent figure would be 3,150 acre feet per year.

The following water balance shows that an 7,500 acre foot reservoir would be needed to withstand two successive years of 1:25 magnitude low runoff:

	Inflow	Initial Storage	Demand	Final Storage
1st Year		7,500	3,150	4,350
2nd Year	1,320	5,670	3,150	2,520
3rd Year	1,320	3,840	3,150	690
4th Year	Sufficient inflow to refill reservoir			

The residual remaining in the reservoir (690 acre feet) in the above balance would be mostly ice.

A similar water balance for a single 1:100 year low flow occurrence would leave 1,860 acre feet in the reservoir at the end of the second year just prior to the replenishing spring runoff. This is further confirmation on reservoir storage requirements of 7,500 acre feet.

The costs suggested in the Three Hills report for a 6,000 acre foot storage, together with land purchase and appurtenances, was $1.28 million. These figures are based on topographic mapping data (1:50,000 scale) and are subject to modification at the preliminary design stage. Increasing the storage by 1,500 acre feet or one quarter will increase the cost by an estimated $150,000.

APPENDIX B

THREE HILLS AND TROCHU WATER SUPPLY

OFFSTREAM STORAGE IN TROCHU

Three Hills and Trochu Water Supply - Offstream Storage in Trochu

Pond Sizing

During the period of heavy turbidity, April 15 - May 15, the demand for water is likely to be equal to the average day demand of 0.88 mgd. However, during the period following, when reservoir recovery is needed, the demand on the reservoir is likely to be in the maximum demand month period or 1.41 mgd.

A reservoir at Trochu must therefore supply the maximum month demand through the summer months (say 3 months x 1.41 x 30 = 126.9 mg) plus net evaporation losses, plus sufficient storage for the 22 day period when the river pumps are shut off, all at a time when the withdrawal rate is 1.41 mgd averaged over the three months. The pipeline must therefore supply the 1.41 mgd for a period sufficient to meet these total demands (reservoir recovery, evaporative losses and mean monthly consumption).

Net evaporative demands using the SNBB (Saskatchewan-Nelson Basin Board - Volume 1 - "Hydrology (stream flows, evaporation and stream flow generation) Appendix 4 data source are as follows:

Consumption:	= 0.88 x 22	
	= 19.5 mg	
Consumptions in:	May 15 - June 15	= 42.3 mg
	June 15 - July 15	= 42.3 mg
	July 15 - Aug. 15	= 42.3 mg

So reservoir size must equal to:

19.4 x 1.357 factor	= 26.32
plus 3 months net evaporation	= 3.34
Total	29.66 mg

Calgary Station

	June	July	August
Maximum Gross Evaporation	6.33	6.70	7.71
Minimum Precipitation	0.26	0.13	0.09
Total	20.26" (1.69 feet)		

Assuming a depth of 15 feet of water in the reservoir the net evaporation will decrease the depth to 13.31 feet which must provide a volume of 19.4 mg (i.e. storage during river shutdown) plus a residual for ice cover and dead storage or an estimate total of 26.32 million gallons (97 acre feet).

The reservoir area needs therefore to be 97/13.31 = 7.28 acres, say 10 acres including dykes and right-of-way around the periphery.

In actual operation the reservoir would be drawn down from a fifteen foot depth to a depth of 4.63 feet during the 22 day shutdown period and a further 1.69 feet (20.26") in evaporation loss during the summer period leaving a residual of 2.94 feet. The 1.41 mgd pumping rate would then have to be extended into the fall to assure reservoir recovery.

On a normal year the yearly pumping volume will still be the average day demand for Three Hills-Trochu plus the evaporative loss on the reservoir, but the pipeline and pump station must be designed for the maximum month in accordance with the above calculations.

The cost estimates for this scheme are discussed in Section 5.8.

APPENDIX C

RIVER INTAKE AND STORAGE POND

River Intake and Storage Pond

Siting Considerations

The Red Deer River is notorious for its heavy sediment loading, which is particularly severe in the Drumheller - Saskatchewan border reach, known locally as "The Badlands."

The heaviest loadings usually occur during the spring runoff period when local creeks contribute significantly to the river flow. However, high concentrations from bank and bed scour also occur during the mountain runoff period if the resulting flows are high and also as a result of local and regional spring and summer heavy rainfall events.

The suspended sediment concentration can be as high as 8,000 mg/L (milligrams per litre) on occasion, and are generally much higher during the open water months than the other Alberta prairie streams which originate on the eastern slopes of the Rocky Mountains. The sediment load is occasionally so high that ordinary water treatment facilities will be badly overtaxed unless pretreatment is initiated.

The best pretreatment for these conditions is thought to be an avoidance altogether of the need to draw water from the river when the suspended sediment exceeds 1,000 mg/L and further to provide a sedimentation pond which will eliminate 30 to 80% of the sediment prior to entering the conventional treatment facility. During periods of heavy turbidity the regional demands would be met by drawing from the storage.

The components of the system would, therefore, include a site on which a sizeable storage reservoir - sedimentation basin complex can be developed, together with a raw water intake, pump station and a new treatment facility to meet the regional water supply demands to the year 2000.

The Red Deer River in this region is characterized by a sand bed which is subject to degradation and aggradation and by shallow water depths during low flow periods. Together with the occasional very high sediment loadings, these factors make construction of a reliable intake very difficult. Bank style intakes, unless they can be tied to a bridge or other existing permanent river structures, are impractical. Bed intakes are likely to be clogged by the heavy sediment load as well as being subjected to extreme ice forces.

The intake style recommended consists of constructing a low level spur dyke along the shore together with a channel to the pump station which will command low level winter flows.

The spur dyke will be trained in the direction of flow such that during average and low flows the river sediments are directed away from the intake channel. Such construction will not, of course, eliminate a tendency for some sedimentation to occur in the intake channel. This problem is addressed by constructing the spur dyke low enough so that high river flows will overtop it and "scoop" out the sediment in the intake channel in the process - hence the name "scoop intake."

Length, height and size of the dyke are a function of river regime and withdrawal rate and are not considered in detail at this time, since considerable field data is needed to proceed with design.

Other siting considerations are:

- Proximity to the demand points.
- Availability of land.
- Accessibility.

Field reconnaissance and an air photo analysis were carried out in the reach of the river between Secondary Highway No. 585 east of Trochu and the City of Drumheller.

Several sites have potential for an intake storage and treatment facility; however, the site immediately north, Munson Ferry, appears to have an advantage of good accessibility, is central to the points of demand and is upstream of two major sediment contributing tributaries, Three Hills and Kneehills Creek.

The proposed site is shown on Plate 4.5. An alternate site which is four (4) miles closer to Drumheller is also shown on the same plate.

In the event a "mini" regional system serving only Trochu and Three Hills is considered, then the site could be moved north to the Highway No. 585 river crossing.

Surface Geology of Treatment Plant Site

The proposed water treatment plant and storage reservoir lies northwest of the access road leading to the Munson Ferry crossing and occupies the area of intersection of Sections 15, 16, 21, and 22, Township 22, Range 21, West of the Fourth Meridian.

The site occupies a terrace of the preglacial Red Deer River. Preliminary examination of available topographic maps and air photographs indicates that this segment of the river is composed of an essentially straight channel with two large sediment bars developed at riffle points upstream and downstream of the ferry crossing. Much of this material can be expected to be of sandy to pebbly sand origin. The accretionary nature of the sediment bars is reflected in the sudden downstream realignment of gully channels as they approach the river shoreline. It is anticipated that the terrace will be composed largely of coarse alluvium with isolated till deposits. Adjacent to the bedrock outcrop, forming the eastern edge of the upland, slope wash deposits consisting of reworked lacustrine clay, till and bedrock form a major portion of the surface veneer.

Topographic maps indicate a relief of some 50 feet from the river's edge to the base of the bedrock outcrop. Most of the area adjacent to the river's edge is essentially horizontal. The relief is predominantly associated with coalesced slope wash fans derived from erosion of the upland. The terrace forms about a 20 foot cliff at the river edge.

Little problem is anticipated with respect to foundation design for the water treatment plant, as the gravel should provide an adequate bearing stratum for the anticipated loads. However, a detailed site investigation program will have to be undertaken to evaluate extent and depth of colluvial and possible alluvial floodplain deposits. These deposits can be expected to be composed of frost susceptible silts.

With regard to the storage pond, suitable materials for a rolled embankment are expected to be of limited lateral extent and of frost susceptible nature if an unlined pond is being contemplated. Suitable till material, however, does occur on the upland both north and south of the ferry crossing in Sections 19 and 31 and Sections 8 and 9, respectively. If a lined pond is contemplated, alluvial terrace material may be used. In addition, there is an upper gravel of glacial spillway origin which forms a terrace on the upland in Section 28 and 32. All deposits require evaluation with respect to compaction criteria and gradation prior to their exploitation.

Design Considerations

To provide sufficient safety for the water supply system it is desirable to build all the river and storage works on the basis of the data of the worst observed sedimentation period. 1974 was the worst year for sediment concentrations since the Bindloss Station began monitoring in the mid-1960's. Suspended sediment ranged from a low of 5 milligrams per litre to a high of 8,700 in 1974.

Unfortunately, there is no sediment data at the considered site. Also, there were no observations at the nearest station at Drumheller in 1974. Therefore, projections of the sediment loading have been made from selected monitoring stations on the river. Three stations were taken for the considerations: at Red Deer, at Drumheller and at Bindloss. Table C.1 showing sediment data follows directly.

The data indicates a very high concentration of sediment at Bindloss and progressively decreasing loading at the stations upstream. April to August means monthly sediment concentration at Drumheller was 20 to 60% less than at Bindloss, and at Red Deer the loadings were negligible by comparison.

Assuming the sediment concentration at Bindloss as 100%, the other stations could be expressed as 49% at Drumheller and 8.9% at Red Deer for the April-August period as shown in Table C.2.

The regional water supply source is proposed to be located upstream from Kneehills Creek and Three Hills Creek which, along with Michichi, are probable sources of major sediment input. Thus, the sediment concentrations in the river at proposed regional sites could be safely assumed to be less than the concentration at both Drumheller and Bindloss.

While the data in Table C.2 is representative of the mean concentrations at the various monitoring stations on a long term basis, the design of the sedimentation storage pond must be tied to periods when the river sediment loading is high, and for this purpose, the 1974 records must be considered in more detail.

The problem is to estimate what the probable concentration of suspended sediment would have been at the proposed regional site during the worst period of 1974. Table C.3 indicates the loading for the Bindloss Station for the period January through June 1974.

TABLE C.1

COMPARATIVE TABLE OF THE
SEDIMENT DATA AT STATIONS ON RED DEER RIVER

Stations on Red Deer River at	Slope	1975 April Q	1975 April C	1975 May Q	1975 May C	1975 June Q	1975 June C	1975 July Q	1975 July C	1975 August Q	1975 August C	1976 April Q	1976 April C	1976 May Q	1976 May C	1976 June Q	1976 June C	1976 July Q	1976 July C	1976 August Q	1976 August C	1977 April Q	1977 April C	1977 May Q	1977 May C	1977 June Q	1977 June C	1977 July Q	1977 July C	1977 August Q	1977 August C	1978 April Q	1978 April C	1978 May Q	1978 May C	1978 June Q	1978 June C	1978 July Q	1978 July C	1978 August Q	1978 August C
Red Deer (Sta.#05CE002)	0.0013	1790	0.25	1960	0.08	1730	0.04	1690	0.038	1240	0.04	1070	0.16	1290	0.02	1500	0.01	1560	0.03	2130	0.15	922	0.18	2610	0.12	2310	0.06	1150	0.01	1500	0.03	-	-	-	0.06	-	0.02	-	0.04	-	0.01
Drumheller (Sta.#05CE001)	0.00036	2900	1.55	3030	0.71	1800	0.43	1760	0.144	1110	0.20	1830	0.50	1130	0.06	1740	0.40	1620	0.06	2040	0.22	1310	0.62	2890	0.99	2750	0.15	1250	0.07	1750	0.2	-	0.344	-	0.476	-	0.418	-	0.06	-	0.04
Rindless (Sta.#05CE004)	0.00033	2610	3.0	3920	1.14	2210	0.56	2340	0.344	1850	0.25	2410	0.78	1220	0.18	2230	0.66	2220	0.09	3470	0.67	1430	0.58	2580	0.96	3120	0.35	1560	0.13	1800	0.22	-	1.19	-	0.56	-	1.07	-	0.24	-	0.58

Q - mean monthly discharge, cfs

C - mean monthly concentration of sediments, gr/litre

NOTE: 1975, 76, 77 and 78 have been taken for comparison as these are the only years observations of all three stations were made (1979 data not available)

TABLE C.2

SEDIMENT CONCENTRATIONS
RED DEER RIVER

		Red Deer	Drumheller	Bindloss
		concentration grams/litre		
1975	April	0.25	1.55	3.0
	May	0.08	0.71	1.14
	June	0.04	0.43	0.56
	July	0.03	0.14	0.34
	August	0.04	0.20	0.25
1976	April	0.16	0.50	0.78
	May	0.02	0.06	0.18
	June	0.03	0.40	0.66
	July	0.03	0.06	0.69
	August	0.15	0.22	1.67
1977	April	0.18	0.62	0.58
	May	0.12	0.99	0.96
	June	0.06	0.15	0.35
	July	0.01	0.07	0.13
	August	0.03	0.02	0.22
1978	April	0	0.34	1.19
	May	0.08	0.48	0.56
	June	0.02	0.41	1.07
	July	0.04	0.06	0.24
	August	0.01	0.04	0.58
	Mean gr/litre	0.068	0.37	0.76
	Mean %	8.9%	49%	100%

TABLE C.3

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ALBERTA

RED DEER RIVER NEAR BINDLOSS - STATION NO. 05CK004

SUSPENDED SEDIMENT FOR 1974

DAY	JAN TEMP. (C)	JAN DAILY DISCHARGE (CFS)	JAN MEAN CONCENTRATION (MG/L)	JAN TONS PER DAY	FEB TEMP. (C)	FEB DAILY DISCHARGE (CFS)	FEB MEAN CONCENTRATION (MG/L)	FEB TONS PER DAY	MAR TEMP. (C)	MAR DAILY DISCHARGE (CFS)	MAR MEAN CONCENTRATION (MG/L)	MAR TONS PER DAY	DAY
1		361 B	20	19.5		288 B	18	14.0		345 B	17	15.8	1
2		361 B	20	19.5		285 B	17	13.1		353 B	18	17.2	2
3		369 B	21	20.9		282 B	16	12.2		353 B	20	19.1	3
4		377 B	21	21.4		282 B	16	12.2		353 B	21	20.0	4
5		345 B	21	19.6		280 B	15	11.3		353 B	22	21.0	5
6		345 B	21	19.6		280 B	14	10.6		353 B	24	22.9	6
7		353 B	21	20.0		280 B	14	10.6		353 B	25	23.8	7
8		353 B	21	20.0		280 B	13	9.8		353 B	26	24.8	8
9		345 B	21	19.6		285 B	12	9.2		353 B	28	26.7	9
10		315 B	22	18.7		285 B	11	8.5		345 B	29	27.0	10
11		293 B	22	17.4		285 B	11	8.5		345 B	30	27.9	11
12		263 B	22	15.6		285 B	10	7.7		345 B	31	28.9	12
13		249 B	22	14.8		293 B	9	7.1		345 B	33	30.7	13
14		249 B	22	14.8		293 B	8	6.3		345 B	34	31.7	14
15		249 B	22	14.8		293 B	8	6.3		353 B	35	33.4	15
16		249 B	22	14.8		293 B	7	5.5		353 B	36	34.3	16
17		235 B	22	14.0		293 B	6	4.7		353 B	38	36.2	17
18		242 B	23	15.0		300 B	6	4.9		353 B	39	37.2	18
19		256 B	23	15.9	0.6	300 B	5 S	4.1		345 B	40	37.3	19
20		278 B	23	17.3		300 B	6	4.9	0.6	330 B	41 S	36.5	20
21		315 B	23	19.6		308 B	7	5.8		385 B	43	40.1	21
22		292 B	24	18.9		308 B	8	6.7		345 B	44	41.0	22
23	0.6	278 B	25 S	18.8		308 B	10	8.3		345 B	46	42.8	23
24		285 B	24	18.5		315 B	11	9.4		338 B	47	42.9	24
25		293 B	24	19.0		315 B	12	10.2		338 B	48	43.8	25
26		293 B	23	18.2		323 B	13	11.3		345 B	48	44.7	26
27		300 B	22	17.8		330 B	14	12.5		353 B	50	47.7	27
28		300 B	21	17.0		338 B	16	14.6		353 B	52	49.6	28
29		300 B	20	16.2						361 B	54	52.6	29
30		293 B	19	15.0						361 B	55	53.6	30
31		293 B	19	15.0						425 B	58	66.6	31
TOTAL		9329		547.2		8307		250.3		10890		1077.8	TOTAL
MEAN		301		17.7		297		8.9		351		34.8	MEAN

DAY	APR TEMP. (C)	APR DAILY DISCHARGE (CFS)	APR MEAN CONCENTRATION (MG/L)	APR TONS PER DAY	MAY TEMP. (C)	MAY DAILY DISCHARGE (CFS)	MAY MEAN CONCENTRATION (MG/L)	MAY TONS PER DAY	JUN TEMP. (C)	JUN DAILY DISCHARGE (CFS)	JUN MEAN CONCENTRATION (MG/L)	JUN TONS PER DAY	DAY
1		377 B	61	62.1	8.9	21600	3930 S	229000	12.8	6400	508 S	8780	1
2		377 B	65	66.2	8.9	18900	2970 S	152000	17.8	5770	511 S	7960	2
3		393 B	68	72.2	8.9	16400	2510 S	111000	17.8	5470	390 S	5760	3
4		425 B	72	82.6	10.0	14000	2160 S	81600	12.8	5080	578 S	7930	4
5		459 B	76	94.2	12.2	11900	2080 S	66800	15.0	4720	524 S	6680	5
6		485 B	80	105	12.2	9470	1500 S	38400	16.1	4460	412 S	4960	6
7		510 B	85	117	12.8	8120	1350 S	29600	16.1	4330	383 S	4480	7
8		537 B	89	129	12.2	7160	1290 S	24900	15.0	4360	319 S	3760	8
9		650 B	93	163	12.8	6640	1190 S	21300	17.2	4410	439 S	5230	9
10		722 B	98	191	12.2	6230	1010 S	17000	17.2	4510	390 S	4750	10
11		968 B	107	280	12.2	6090	866 S	14200	18.3	4600	423 S	5250	11
12		2460 B	459	3050	12.8	6090	846 S	13900	22.2	4530	402 S	4920	12
13		3520 B	1280	12200	12.2	5940	746 S	12000	22.2	4650	434 S	5450	13
14	0.6	6220 B	3040 S	51100	10.0	5700	784 S	12100	22.2	4560	404 S	4970	14
15	0.6	8920 B	6920 S	167000	12.2	5660	852 S	13000	20.0	4380	281 S	3320	15
16	0.6	11600 B	8700 S	272000	12.8	5750	1220 S	18900	22.8	4190	229 S	2590	16
17	2.2	14400 B	7020 S	273000	12.2	6090	2140 S	35200	25.0	4840	363 S	4740	17
18	2.8	16400 B	8200 S	363000	8.9	7370	1680 S	33400	23.9	6120	564 S	9320	18
19	3.9	18200	7740 S	380000	11.1	7480	1220 S	24600	25.0	6420	621 S	10800	19
20	4.4	21200	5690 S	326000	11.1	8220	1210 S	26900	22.8	7140	750 S	14500	20
21	5.0	24200	4830 S	316000	8.9	8680	1350 S	31600	22.2	10100	1050 S	28600	21
22	5.0	25900	4830 S	338000	10.0	8590	1210 S	28100	22.8	10200	1230 S	33900	22
23	5.6	23400	4160 S	263000	10.6	10600	1290 S	36900	23.9	8600	1240 S	28800	23
24	8.3	21700	4180 S	245000	12.8	9920	950 S	25400	25.0	7310	1130 S	22300	24
25	10.0	18300	3350 S	166000	14.4	8590	740 S	17200	25.0	7030	927 S	17600	25
26	11.1	16300	2810 S	124000	15.6	7810	707 S	14900	22.8	7340	823 S	16300	26
27	8.3	15300	3030 S	125000	15.0	6780	658 S	12000	22.8	6980	858 S	16200	27
28	8.3	14700	2820 S	112000	15.0	6390	559 S	9640	22.2	7010	1030 S	19500	28
29	8.9	18300	3690 S	182000	13.9	6310	542 S	9230	22.2	8110	1540 S	33700	29
30	9.4	20500	5280 S	292000	12.8	6500	537 S	9420	21.1	6450	2210 S	38500	30
31					15.0	6940	508 S	9520					31
TOTAL		307423		4011712.3		271920		1179710		180070		381550	TOTAL
MEAN		10200		134000		8770		38100		6000		12700	MEAN

Data from "Sediment Data of Canadian Rivers - 1974"
Water Survey of Canada
Environment Canada

The heaviest loadings occurred during the period April 14 through May 5 and averaged 4,540.0 mg/L when the average river flow was approximately 17,200 cfs.

Table C.4 shows that the Red Deer Monitoring Station had mean concentrations of 420.0 mg/L at mean flow of 6,240 cfs for the same April 14 to May 5 period.

It is evident that the river picked up a considerable amount of sediment in the intervening length between the two stations. Since 1974 data is not available for Drumheller Station, a review of data for the 1975 to 1978 period when the Drumheller station was monitored is pertinent. Table C.5 summarizes mean concentrations for each station for each year during the period of heaviest loading. The data upholds the earlier indication that Red Deer Station has significantly lower sediment concentration during high flows than either Drumheller or Bindloss.

The data also indicates that the concentrations at Drumheller range from 39% to 90% of those at Bindloss.

TABLE C.4

ALBERTA

RED DEER RIVER AT RED DEER - STATION NO. 05CC002

SUSPENDED SEDIMENT FOR 1974

DAY	JAN TEMP. (C)	JAN DAILY DISCHARGE (CFS)	JAN MEAN CONCENTRATION (MG/L)	JAN TONS PER DAY	FEB TEMP. (C)	FEB DAILY DISCHARGE (CFS)	FEB MEAN CONCENTRATION (MG/L)	FEB TONS PER DAY	MAR TEMP. (C)	MAR DAILY DISCHARGE (CFS)	MAR MEAN CONCENTRATION (MG/L)	MAR TONS PER DAY	DAY
1		390 B				318 B				330 B	7	6.2	1
2		384 B				318 B				324 B	7	6.1	2
3		372 B				318 B				330 B	7	6.2	3
4		366 B				324 B				342 B	7	6.5	4
5		354 B				336 B				342 B	7	6.5	5
6		348 B				360 B				342 B	7	6.5	6
7		336 B				366 B				336 B	7	6.4	7
8		324 B				378 B				330 B	7	6.2	8
9		306 B				384 B				324 B	7	6.1	9
10		306 B				390 B				318 B	7	6.0	10
11		306 B				402 B				324 B	7	6.1	11
12		306 B				402 B			0.6	342 B	7 S	6.5	12
13		306 B				402 B			0.6	376 B	4 S	4.1	13
14		306 B				402 B				362 B	3	2.9	14
15		306 B				402 B				362 B	4	3.9	15
16		300 B				390 B				355 B	4	3.8	16
17		300 B				390 B				349 B	4	3.8	17
18		300 B				390 B				336 B	4	3.6	18
19		300 B				390 B				330 B	5	4.5	19
20		300 B				384 B			0.6	322 B	5 S	4.3	20
21		306 B				378 B				316 B	5	4.3	21
22		306 B				378 B				310 B	4	3.3	22
23		306 B				372 B				303 B	4	3.3	23
24		306 B				366 B				303 B	3	2.5	24
25		306 B				360 B				303 B	3	2.5	25
26		318 B				354 B				310 B	2	1.7	26
27		318 B				348 B			0.6	310 B	2 S	1.7	27
28		318 B				342 B				330 B	2	1.8	28
29		318 B								369 B	3	3.0	29
30		318 B								390 B	3	3.2	30
31		318 B								433 B	4	4.7	31
TOTAL		9954				10344				10453		138.2	TOTAL
MEAN		321				369				337		4.5	MEAN

DAY	APR TEMP. (C)	APR DAILY DISCHARGE (CFS)	APR MEAN CONCENTRATION (MG/L)	APR TONS PER DAY	MAY TEMP. (C)	MAY DAILY DISCHARGE (CFS)	MAY MEAN CONCENTRATION (MG/L)	MAY TONS PER DAY	JUN TEMP. (C)	JUN DAILY DISCHARGE (CFS)	JUN MEAN CONCENTRATION (MG/L)	JUN TONS PER DAY	DAY
1	0.6	480 B	4 S	4.8	8.9	7860	308 S	6540		3670	45	446	1
2		397 B	4	4.3	7.2	7160	295 S	5700	15.0	3360	30 S	272	2
3	0.6	448 B	4 S	4.8	11.1	5300	166 S	2380		3330	32	288	3
4		440 B	4	4.8		4100	104	1150	11.7	3570	50 S	482	4
5		397 B	4	4.3	13.3	3600	88 S	855		3410	46	424	5
6		397 B	4	4.3		3490	81	763		3190	39	336	6
7		411 B	4	4.4		3730	76	765	14.4	3190	32 S	276	7
8		418 B	4	4.5	11.1	3740	71 S	717		3490	42	396	8
9		623 B	45	75.7		3630	60	588	13.9	3620	43 S	420	9
10		716 B	152	294		3330	45 S	405		3490	32	302	10
11		870 B	261	613		3060	31	256	16.7	3250	23 S	202	11
12		1520 B	373	1530		2930	28 S	222		3280	20	177	12
13		2110 B	374	2130		3340	67	604	17.8	4690	259 S	3280	13
14		2470 B	463	3090		4540	111 S	1360		5800	470	7360	14
15		2670 B	1060	7640		4970	121	1620		5690	459	7050	15
16		2470 B	1460	9740		5400	112 S	1630	17.2	6060	515 S	8430	16
17	2.2	2990 B	1060 S	8560		6140	179 S	2970	17.2	7400	903 S	18000	17
18	2.2	8020 B	618 S	13400		6070	178	2920	16.7	8010	1460 S	31600	18
19	2.8	8420	541 S	12300		6880	254	4720	16.7	7210	1090 S	21200	19
20	3.3	10000	669 S	18100		7330	293 S	5800	15.0	6260	690 S	11700	20
21	4.4	9550	412 S	10600		6540	173	3050	16.7	6230	602 S	10100	21
22	6.7	8180	221 S	4880	11.7	5950	125 S	2010	16.7	6380	589 S	10100	22
23	8.3	7070	148 S	2830	12.2	5440	104 S	1530	16.7	6000	564 S	9140	23
24	10.0	6080	120 S	1970	13.3	5290	103 S	1470	16.1	5930	517 S	8280	24
25	10.0	5330	100 S	1440	13.9	5360	119 S	1720	16.7	6070	554 S	9080	25
26	10.0	4960	97 S	1300	14.4	5540	169 S	2530	16.1	5810	461 S	7230	26
27	7.8	5910	186 S	2970	11.7	6130	340 S	5630		5590	392	5920	27
28	2.8	8030	425 S	9210	11.7	5680	215 S	3300	15.6	4620	297 S	3700	28
29	8.3	8650	384 S	8970	11.1	4980	114 S	1530		3770	223	2270	29
30	8.9	8520	333 S	7660	11.7	4610	76 S	946	18.3	3350	185 S	1670	30
31						4130	60	669					31
TOTAL		118507		129338.9		156250		66350		145720		180131	TOTAL
MEAN		3950		4310		5040		2140		4860		6000	MEAN

Data from "Sediment Data of Canadian Rivers"
Water Survey of Canada
Environment Canada

Table C.5
Sediment Load, Red Deer River
April to May 1974

	Mean Concentration of Sediment Grams/Litre During Worst Sediment Period			
	Red Deer	Drumheller	Bindloss	Mean Flow at Drumheller cfs
1975 (April 16-May 15) 30 days	0.16	1.20	1.79	4,725
1976 (April 1-April 15) 15 days	0.14	0.525	0.78	2,550
1977 (May 11-May 31) 20 days	0.11	0.99	1.1	3,730
1978 (June 1-June 30) 30 days	0.22	0.42	1.07	4,670

Note: cfs refers to cubic feet per second

It is important to note that the river flow during the high sediment periods for each year 2975 to 1978 were significantly lower than the 17,200 cfs mean flow recorded during the heavy sediment loading period in 1974.

In very high flow years such as 1974 the tributary stream will, of course, contribute considerable sediment, but in addition to this, there is a great deal of bank erosion and river bed degradation occurring which adds to the suspended sediment concentration.

It may be reasoned, therefore, that during high flow events the sediment concentration is likely to parallel the rate of flow in the river (i.e. concentration is proportional to flow) provided river regime characteristics are similar.

Table C.6 is a summary of recorded 1974 flow data for the Red Deer and tributary for the critical April-May period in 1974. Inserted into the table are estimated local and unrecorded tributary inflow upstream of the proposed regional water supply intake site (Haynes, Parlby, Tail and Big Valley Creeks) as well as downstream (Michichi Creek).

The recorded average flow rate at Drumheller is 90% of Bindloss. The river regime is similar for these two locations. At Red Deer, which is characterized by a different river regime, the flow rate was approximately 34% of that at Bindloss.

The proposed site for the regional supply is located upstream of Three Hills Creek and from Table C.6 the estimated flow rate at this point would have been approximately 11,000 cfs or 670% of the Bindloss flow rate. The river regime is again similar to Bindloss and Drumheller, and the valley is characterized by eroded walls essentially devoid of vegetation and river banks composed of erodible silt sand deposits.

The foregoing discussion would appear to justify the assumption that during the worst sediment conditions the concentration of suspended sediment at the proposed site would be no greater than 60% of that at the Bindloss Station. On this basis, the daily mean suspended sediment loadings depicted for Bindloss may be adjusted to 60% for the proposed regional site.

Table C.6
April and Early May Contributions of Creeks
Contributory to the Red Deer River in 1974

	Mean Daily Flow cfs**
Red Deer River at Red Deer April 16 - May 5	6,100
Three Hills Creek at Carbon April 11 - April 30	850
Ghost Pine Creek	(450) estimate*
Kneehills Creek Near Drumheller April 11 - April 30	1,450
Miscellaneous Inflow Upstream of Site	(5,000)
Miscellaneous Inflow Downstream of Site	(2,450)
Red Deer River at Drumheller April 16 - May 5	16,300
Rosebud River near Redland April 16 - May 5	700
Bullpound Creek April 18 - May 5	75
Matzhiwin Creek April 8 - April 30	150
One Tree Creek April 8 - April 30	100
Berry Creek April 26 - May 5	1,050
Blood Indian Creek April 16 - May 5	150
Red Deer River at Bindloss April 16 - May 5	18,200

Note: 1. Figures are imprecise due to time delay in flow routing - use as a guide only.
2. Bracketed figures are estimated by UMA. Other figures are averages obtained from flow records by Water Survey Canada for period indicated.

* Estimate on basis of drainage area relationship to Three Hills Creek
**cfs refers to cubic feet per second

Suspended sediment loadings of 1,000 mg/L or less can be handled adequately in a combined storage-sedimentation pond located at the intake site. Accordingly, the period of concern, from Table C.3, is April 14 to May 5, 1974 or 22 days when it is not desirable to pump water out of the river. This enables a calculation of the size of the storage pond as follows:

Total storage volume based on the average day demand during the high turbidity period is:

3.16×10^6 gallons per day x 22 - 69.52 million gallons.

A reservoir with 70 million gallons of usable storage would therefore, enable the river pumps to be shut off during a 22 day period. The actual storage volume in the reservoir should be increased, however, to allow for possible ice cover and sufficient reserve volume to provide for sedimentation of greater than 1,000 mg/L river water after the elapse of the 22 day period. The desirable gross storage volume is recommended at 95 million gallons or 350 acre feet.

The pond dimensions should be 1,640 feet x 656 feet with a 15.0 foot depth, and it will require an area of approximately 25 acres. Since the above analysis is based on providing facilities to the year 2000, it is recommended that right-of-way be secured in the amount of 65 acres, thereby providing for future pond enlargement to carry the system to the year 2020.

As was noted earlier, it is assumed the river pumping station would be cut off in the worst sediment period. It is proposed that the pond be utilized as a sedimentation basin during the rest of the year, pumping water from the river into the pond with a low lift pumping station and out from the pond to the treatment plant and thence to the high lift pumping station. Such a scheme would allow for the use of significant reduction in expensive settling coagulants in the treatment plant.

To determine the volume of sediment which could settle in the pond during an average year, the minimum diameter of particles which would settle in the path between outlet and pond inlet structures was calculated to be 0.002 mm.

Particles larger than 0.002 mm will, therefore, settle in the pond, and in order to determine the volume of sedimentation which will occur, the analysis of monthly sedimentation records presented in Table C.2 was used.

On a mean monthly basis it is assumed that the concentration of suspended sediment at the proposed site will not exceed 40% of the concentration at Bindloss. Table C.7 illustrates the mean monthly concentrations at Bindloss for the period of record, and the bottom line of the table indicates the average monthly concentrations anticipated at the proposed regional site. The data is translated into particle size curves in Plate C.1 from which it is estimated that when the river pump is operating (i.e. when river suspended sediment is less than 1,000 mg/L), the percentage of sedimentation anticipated in the pond would be:

April	83%
May	86%
June	66%
September	86%

The volume of sediment anticipated in the pond for an average year is calculated in Table C.7.

It is likely that much of the sediment will settle soon after the water enters the reservoir, and accordingly, the internal dyke system is designed to permit the first bay to be isolated, drained and cleaned out while the second bay maintains service to the City. This cleanout activity should be needed every five or ten years and should be performed during the months of September or October when both demand and river loading are down. The amount of sediment will, of

TABLE C.7

SEDIMENT DATA

Red Deer River near Bindloss (Station No. 05CE004)-mean monthly concentration grams/litre

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Years
				0.28	0.81	1.89	0.43	0.23	0.07	0.055	0.049	1966
0.011	0.008	0.024	2.030	0.86	1.30	0.245	0.175	0.060	0.075	0.095	0.149	1967
0.092	0.062	0.105	0.174	0.272	1.01	1.16	0.439	0.514	0.221	0.04	0.03	1968
0.024	0.006	0.020	1.910	0.618	0.456	1.49	0.254	1.750	0.317	0.054	0.035	1969
0.129	0.072	0.058	1.040	0.235	1.58	1.040	0.182	0.099	0.26	0.08	0.117	1970
0.08	0.13	0.06	3.99	0.45	1.25	0.53	0.32	0.13	0.09	0.03	0.03	1971
0.05	0.02	0.80	0.94	0.27	1.71	0.88	0.38	0.32	0.07	0.056	0.01	1972
0.02	0.02	0.28	1.21	0.48	1.59	0.43	0.36	0.24	0.02	0.01	0.01	1973
0.02	0	0.03	4.79	1.58	0.77	0.41	0.34	0.28	0.12	0.03	0	1974
0.08	0.05	0.03	3.0	1.14	0.56	0.34	0.25	0.20	0.07	0.07	0	1975
0	0	0.37	0.78	0.18	0.66	0.69	1.67	0.12	0.07	0.02	0	1976
0	0.02	0.05	0.58	0.96	0.35	0.13	0.22	1.31	0.32	0.11	0.05	1977
0.03	0.01	0	1.19	0.56	1.07	0.24	0.58	1.61	0.12	0.07	0.01	1978
0.04	0.03	0.15	1.79	0.61	1.01	0.76	0.43	0.53	0.13	0.06	0.04	MEAN
0.016	0.012	0.06	0.28	0.24	0.40	0.30	0.16	0.20	0.05	0.02	0.016 (To be used at proposed site (R:04))	

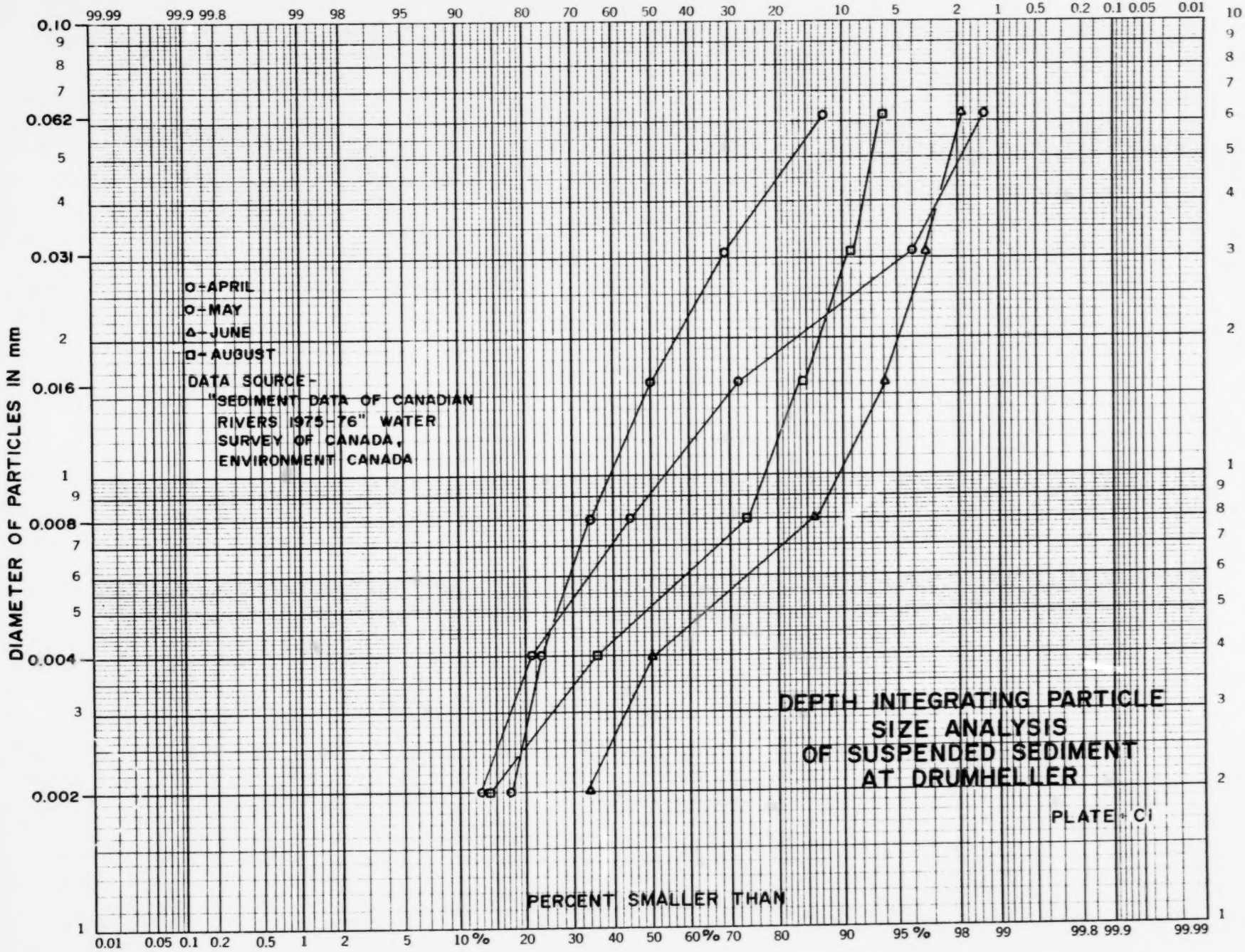
TABLE C.8

SEDIMENT VOLUME
RAW WATER STORAGE POND

Month	Concentration at Proposed Regional Site g /l	Percentage of Particles-size more than .0020mm %	Volume of sedimentation anticipated in pond m^3	Concentration of sediment required treatment gr/l	Amount of sediment requiring treatment m^3
Jan.	0.16	80%	46.6	0.032	9.3
Feb.	0.012	80%	3.5	0.0024	0.7
March	0.06	80%	17.5	0.012	5.3
April	0.28	83%	84.7	0.048	17.3
May	0.26	87%	121.6	0.031	18.1
June	0.40	66%	153.9	0.136	79.3
July	0.30	86%	150.4	0.042	24.4
August	0.16	80%	74.6	0.03	14.9
Sept.	0.20	80%	93.3	0.04	18.7
Oct.	0.05	80%	14.6	0.01	2.8
Nov.	0.02	80%	5.8	0.004	1.2
Dec.	0.016	80%	46.6	0.003	9.3
			813.0 m^3		201.3 m^3

The depth of deposition of sediment in the pond in the average year would be approximately 1 cm. (0.4 inches)

m^3 = one cubic metre 1.308 cu.yd.
g/l = grams per litre


DIAMETER OF PARTICLES IN mm
0.10
0.062
0.031
0.016
0.008
0.004
0.002
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
0.01 0.05 0.1 0.2 0.5 1 2 5 10 % 20 30 40 50 60% 70 80 90 95 % 98 99 99.8 99.9 99.99
PERCENT SMALLER THAN
O-APRIL
O-MAY
Δ-JUNE
□-AUGUST
DATA SOURCE-
"SEDIMENT DATA OF CANADIAN RIVERS 1975-76" WATER SURVEY OF CANADA, ENVIRONMENT CANADA
DEPTH INTEGRATING PARTICLE SIZE ANALYSIS OF SUSPENDED SEDIMENT AT DRUMHELLER
PLATE C1

course, increase with time as the demand increases, but it will not be a major maintenance factor even at year 2020.

It is desirable that the two bays in the reservoir be drained once each year to control algae and water weed growth.

The river pump station should be sized to meet maximum demand month (6.98 x 1.6 m) plus the necessary storage recovery rate or 11.17 x 2 mgd at the year 2020. However, the pumps that are installed at the time of initial construction would be sized to meet the maximum month demand at year 2000 or 2 x 5.05 mgd.

APPENDIX D

PRESENT WORTH ANALYSIS

Table D.1
Present Worth Analysis
Regional Water Supply System

Two Percent

Alternative	Time Period	Capital Costs	P.F	P.W. Capital	Operation Costs	P/A	P/F	P.W. Operating	Total Present Worth
#1	1980-1985	$14,981,000		$14,981,000	$267,335	4.7134		$1,260,100	
	1985-1990				293,915	4.7134	0.9057	1,254,700	
	1990-1995	660,000	0.8203	541,400	325,660	4.7134	0.8203	1,259,100	
	1995-2000				363,450	4.7134	0.7430	1,272,800	
				$15,522,400				$5,046,700	$20,569,100
#2	1980-1985	$15,096,500		$15,096,500	$251,755	4.7134		$1,186,600	
	1985-1990				273,065	4.7134	0.9057	1,165,700	
	1990-1995	670,000	0.8203	549,600	298,040	4.7134	0.8203	1,152,300	
	1995-2000				326,530	4.7134	0.7430	1,143,500	
				$15,646,100				$4,648,100	$20,294,200
#3	1980-1985	$15,115,000		$15,115,000	$210,990	4.7134		$ 994,500	
	1985-1990				236,435	4.7134	0.9057	1,009,300	
	1990-1995	510,000	0.8203	418,400	266,410	4.7134	0.8203	1,030,000	
	1995-2000				304,050	4.7134	0.7430	1,064,800	
				$15,533,400				$4,098,600	$19,632,000
#4	1980-1985	$15,643,000		$15,643,000	$262,595	4.7134		$1,237,700	
	1985-1990				286,715	4.7134	0.9057	1,224,000	
	1990-1995	800,000	0.8203	656,200	315,130	4.7134	0.8203	1,218,400	
	1995-2000				347,525	4.7134	0.7430	1,217,100	
				$16,299,200				$4,897,200	$21,196,400

Table D.2
Present Worth Analysis
Regional Water Supply System

Eight Percent

Alternative	Time Period	Capital Costs	P.F	P.W. Capital	Operation Costs	P/A	P/F	P.W. Operating	Total Present Worth
#1	1980-1985	$14,981,000		$14,981,000	$267,335	3.9927		$1,067,400	
	1985-1990				293,915	3.9927	0.6805	798,600	
	1990-1995	660,000	0.4632	305,700	325,660	3.9927	0.4632	602,300	
	1995-2000				363,450	3.9927	0.3152	457,400	
				$15,286,700				$2,925,700	$18,212,400
#2	1980-1985	$15,096,500		$15,096,500	$251,755	3.9927		$1,005,200	
	1985-1990				273,065	3.9927	0.6805	741,900	
	1990-1995	670,000	0.4632	310,300	298,040	3.9927	0.4632	551,200	
	1995-2000				326,530	3.9927	0.3152	410,900	
				$15,406,800				$2,709,200	$18,116,000
#3	1980-1985	$15,115,000		$15,115,000	$210,990	3.9927		$ 842,400	
	1985-1990				236,435	3.9927	0.6805	642,400	
	1990-1995	510,000	0.4632	236,200	266,410	3.9927	0.4632	492,700	
	1995-2000				304,050	3.9927	0.3152	382,600	
				$15,351,200				$2,360,100	$17,711,300
#4	1980-1985	$15,643,000		$15,643,000	$262,595	3.9927		$1,048,500	
	1985-1990				286,715	3.9927	0.6805	779,000	
	1990-1995	800,000	0.4632	370,600	315,130	3.9927	0.4632	582,800	
	1995-2000				347,525	3.9927	0.3152	437,400	
				$16,013,600				$2,847,700	$18,861,300

POOR

QUALITY

ORIGINAL